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Edited by

LEON · GASTER

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EDITORIAL.

A Year's Progress.

In accordance with our usual custom at the commencement of each year we take the opportunity of reviewing progress. Some of the most important developments of the year were dealt with in the Report of Progress during the Vacation, submitted at the opening meeting of the Illuminating Engineering Society on Nov. 17th and published in our last number. Other items were summarized in the Annual Report of the Council presented at the General Meeting last May. It is one of the signs of the rapidity with which events move that it should be necessary thus to summarize progress at frequent intervals; we may, however, be excused from dwelling on the events recorded in these two reports, to which readers are referred for fuller details.

The Illuminating Engineering Society.

The Illuminating Engineering Society has just entered upon its third session. Its membership has now increased to over 300, and it has received the support of many well-known authorities during the past year. Meetings have been held at which the subjects of school and library lighting, the reflection from walls and ceilings, motor car headlights, and railway lighting have been discussed and the support of kindred societies and associations interested in these subjects has been sought and obtained. The support received from our corresponding members from their respective countries formed a valuable element in the discussion of the papers read.

International Congresses during the Year.

The activity of the Society outside its own meetings has been equally important. As explained in our last number its influence was exerted at the meetings of the International Electrical Congress and the International Electrotechnical Commission in Turin with the

exceedingly important result that the Congress sanctioned the formation of an International Commission to deal with illumination; in addition to this the International Electrotechnical Commission decided that in treating illumination the co-operation of the Illuminating Engineering Societies in their respective countries should be secured. It need only be said now that they present the Illuminating Engineering Societies in this country and in the United States with an excellent opportunity of co-operating with the other existing photometric commissions and putting the subject of illumination on a better international footing.

It will be recalled that the Society participated in the International Hygienic Exhibition at Dresden, the Annual Congress of the Royal Sanitary Institute, and other important gatherings. During the year there have been several other congresses dealing with illumination, including the International Photometric Commission at Zurich, and the Fifth Annual Convention of the Illuminating Engineering Society in the United States.

Number of Articles and Papers on Illumination still Increasing.

At the beginning of each year we have had to call attention to the rapidly increasing number of contributions on illumination both before technical and scientific societies, and among such societies and institutions we note this year:—

The Institution of Civil Engineers, Institution of Gas Engineers, Royal Sanitary Institute, Institute of Sanitary Engineers, Optical Society, Royal Photographic Society, Exhibition of Applied Chemistry, Electrical Contractors' Association, &c.

The number of interesting contributions on lighting matters in the press has also been greater than in any previous year and,—what is specially gratifying to see—the standpoint of the Illuminating Engineering Society is being very generally adopted.

Factory Lighting and the Hygienic Aspects of Illumination.

This is a matter on which we have already commented in previous numbers. Little need now be done except to recapitulate some of the most important events of the past year.

The Annual Report of H.M. Chief Inspector of Factories contained evidence of a sympathetic consideration of the claims of good illumination.

The Report of the Departmental Committee on Accidents in Factories and Workshops took a similar view, and also urged the need for some general statutory requirement of good lighting; the desirability was also pointed out of taking steps to establish some more definite standard of the amount of illumination required. This report contained striking evidence of the bad results of imperfect illumination in textile works, boiler houses, goods yards, &c.

Meantime a movement in favour of improved illumination has led to the formation of The National Association for the Conservation of Vision in the United States, which will no doubt serve to supplement the work of the Illuminating Engineering Societies in America and in this country.

What, however, is perhaps the greatest step taken during the year, is the establishment of a Committee on the Hygienic Aspects of Illumination by the French Government—a precedent which, it is hoped, will be followed shortly by other countries.

Street-lighting.

The question of street-lighting has again been well to the front in this country. We see a growing recognition of the necessity of raising the standard of illumination in many poorly lighted thoroughfares.

An interesting incident has been the co-operation of the gas and electric lighting companies in the Borough of Holborn, and the acceptance of a joint specification providing for some streets

to be lighted by gas and others by electricity.

We find also that an arrangement, not unlike that entered into at Holborn, has been adopted in lighting the important thoroughfares in the City of London, where a combined scheme of gas and electric lighting has also been agreed upon.

The other important event of the year has been the formation of the Joint Committee, attended by representatives of the Institutions of Gas and Electrical Engineers, the Illuminating Engineering Society, and the Association of Municipal and County Engineers, to consider the drafting of a standard specification on street-lighting. This Committee is still meeting, and its final report will be awaited with much interest.

Education in Illuminating Engineering.

During the year the London County Council Education Department has had this matter under their consideration, and special courses were arranged at the Regent Street Polytechnic and Battersea Polytechnic. These courses are, we believe, quite unique in one respect, namely, that the various subjects are to be dealt with by experts in their respective departments. The first six lectures have already taken place, and the remaining six will be delivered early in the new year.

A course of lectures on illumination has also been arranged at the Northampton Institute, and we now learn that a more advanced series of lectures is also to take place at University College, where so much admirable work on photometry has been carried out under the supervision of Dr. Fleming. We trust that it will only be a question of time for such courses to become an integral part of the courses of instruction for engineering and architectural students at the various educational centres in this country. Thanks are due to the governing bodies of these Institutions for granting the necessary facilities for these courses to be held.

Scientific Methods in Practical Work.

As regards actual novelties in lamps there have not been many very striking developments to record. In gas lighting, perhaps the most important step has been the introduction of several types of high candle-power low pressure lamps which are stated to produce, on an ordinary low pressure gas supply, an efficiency which could barely have been attained by high pressure a few years ago. In electric lighting we have seen the introduction of the drawn wire tungsten lamp; it is even more satisfactory to see that the British Thomson Houston Company has established an illuminating engineering department, and is endeavouring to educate the public in the best methods of *using* these lamps. There has been a notable reduction in the price of metallic filament lamps, and several new forms of enclosed flame arc lamps have also made their appearance. Dr. Ives has described experiments which may have important consequences in the production of artificial daylight, and the application of fluorescent materials to improve the colour of the mercury vapour lamp may be noted.

But the most gratifying feature of practical progress during the past year has been the steady introduction of more scientific methods of educating the public in lighting matters. A notable instance of improvement in this direction is furnished by the advance in much of the literature issued to the public. We may here mention the well got up publication of Holophane Ltd., in which much practical information is given on the best methods of using Holophane globes and reflectors to obtain the most efficient results with the different illuminants available. The photography of artificially lighted interiors is developing into a fine art, and vastly improved results can now be secured compared

with those commonly presented only two or three years ago.

To sum up, therefore, the signs of progress during the preceding year have been distinctly encouraging. The outlook for the next is equally bright, and we hope that by the beginning of 1913 there will again be solid progress to report. We take this opportunity of thanking our many supporters in different parts of the world who have given to the movement and to this journal their constant aid during the past year. We trust that this encouragement will be maintained in the future.

Railway Lighting.

On pages 25-32 readers will find Mr. Harrison's interesting paper on Railway Station and Goods Yard Illumination, read at the last meeting of the Illuminating Engineering Society, and following this some data presented at the meeting by Mr. Dow, giving the results of some tests on the underground railways.

The discussion was also very useful, a number of engineers connected with the leading railways taking part.

There can be no doubt but that the question of station lighting is considered in a much more scientific manner now than it used to be. Already we see a general rise in the degree of illumination on main platforms and a tendency to make the utmost use of convenient illuminated signs, both for the direction of passengers and as advertisements. In the same way it is most gratifying to notice that in the most modern methods of lighting, particularly on some of the tube railways, special attention is being paid to the elimination of glare. When this subject was discussed at a meeting of the Illuminating Engineering Society less than two years ago, the importance of this point was brought prominently forward, and there were many engineers who, perhaps, realized for the first time how destructive of true efficiency the effects of glare may be. We have now abundant evidence that this view is much more generally appreciated, and we continually see new signs of progress in this respect.

One of the most important suggestions in Mr. Harrison's paper, to which much of the discussion was devoted, related to the possibility of establishing a minimum illumination on railway platforms. Naturally in framing any standard of this kind, one must bear in mind the requirements of different classes of platforms. It will be observed, however, that the independent tests presented by Mr. Dow served to show that the minimum value suggested by Mr. Harrison, namely, 0·25 foot-candles, was one with which many railways had already complied, and which would probably not be considered unreasonable for important stations.

In conclusion we should like to lay stress on one point very ably brought out by Mr. Roger T. Smith in the course of his remarks at the meeting, namely, the fact that it is impossible to lay down any general rule in favour of one illuminant. There are often local circumstances, quite apart from the merits of gas and electricity as lighting agents, which settle the selection of one or the other. The important thing to determine, therefore, is the amount of illumination required irrespective of the illuminant employed to obtain it. If the Illuminating Engineering Society could be instrumental in determining a certain minimum illumination, it is probable that the illuminant, whether gas, oil, acetylene, or electricity, &c., could, with proper care, be arranged to comply with their recommendations in this respect. We feel sure that this paper and discussion was most interesting and valuable to engineers of railway companies, and that the Illuminating Engineering Society will always be glad to co-operate with them in dealing with these problems in the future.

LEON GASTER.

Review of Contents of this Issue.

THE Technical Section opens with an article by CLAYTON H. SHARP and PRESTON S. MILLAR, in which they describe a new small model of their **Universal Portable Photometer.** The authors point out that it is an important principle, to be recognized in connexion with portable instruments, that although observational errors up to, say, 3 or 4 per cent, may be permissible, there should be no inherent errors due to the construction of the instrument; and hence in designing this small model care has been taken to incorporate the essential features of the former model, so that there is only a loss of accuracy as far as the reading is concerned. A diagram is given showing the arrangement and principle of the photometer, and a special device for adjusting the current in the standard lamp is described. This consists in measuring the resistance of the lamp which forms one arm of a Wheatstone bridge. An adjustable resistance is obtained by means of a slide wire, and a telephone receiver is used to indicate when the bridge is balanced. The adjustment can thus be made within one milliampere. The article concludes with a description of the procedure in calibrating the instrument and in carrying out the measurements of candle-power or illumination.

Following this on p. 12 is an article by J. S. DOW and V. H. MACKINNEY describing some **New Apparatus for the Measurement of Light and Illumination.** They deal first with the new model of the Holophane Lumeter, and point out the advantages resulting from the changes in the design of this apparatus, which is now much more compact, has a single scale, and is provided with dark glasses which largely increase the range, so that it is possible to read up to 2,000 foot-candles. Among the accessory apparatus described by the authors is the special screen which can be attached to the front of the instrument so as to make the colour of daylight similar to that of the tungsten lamp inside, and thus facilitate daylight measurement. Another device has been introduced for measuring the daylight illumination in a room compared with the brightness of the sky, in the manner described by Mr. P. J. Waldram, thus obtaining in a very simple manner a measure of the access of daylight to the room. The article concludes with a description of a new arrangement for obtaining polar curves of light distribution. A diagram of this apparatus is given, and its advantages are summarized.

PROF. SILVANUS P. THOMPSON contributes a **Note on the Measurement of Solid-Angles** (p. 15), in which he shows the relation between the "sterean" and the "square-degree," and refers to the use of the latter unit in an article by Prof. Weber in the last issue.

A note dealing with the new **Lighting in the City of London** appears on p. 16. He draws attention to the scheme of combined gas and electric lighting, by which certain of the streets are allotted to gas, whilst others are lighted electrically. A feature in many of the streets is the central suspension of the light sources. It is noteworthy that while £6,000 a year will be saved by the new scheme, the illumination of the streets will be quite up to the former standard.

On p. 18 will be found some announcements with regard to the courses of **Lectures on Illuminating Engineering** at Regent Street, Battersea, and Northampton Polytechnics. Some details are also given of the special advanced course at University College, London, which will be delivered by Prof. W. C. Clinton, more particularly for those who have already some acquaintance with lighting problems, but are desirous of extending their theoretical knowledge.

An account of a recent meeting of the Electrical Contractors' Association, at which MR. JUSTUS ECK read a paper

on **Indirect Lighting by Arc Lamps,** appears on p. 18. The paper was illustrated by excellent lantern slides showing the various applications of arc lamps, and the author laid stress on the value of the indirect system in producing soft shadow and eliminating glare.

The Electric Lighting of Railway Trains by the Brake Vehicle Method is described by MR. ROGER T. SMITH on p. 20. The author, in introducing the subject, mentions some of the principal requirements of an efficient train-lighting system, discusses the methods of charging and regulating the batteries which are in common use, and then describes the " brake-vehicle " method. The name is derived from the fact that only the brake vehicle in each train, or section of a train, is fitted with generator and battery, the remaining coaches being only wired and provided with electrical couplings. Considerable economy is thus effected, and the author concludes by working out an actual example indicating how this saving can be secured.

A note on the reflection from coloured wall-papers, with some interesting figures showing percentage of light absorbed, follows this article (p. 22).

The section of the magazine devoted to the *Transactions* of the Illuminating Engineering Society (p. 23) opens with an account of the meeting held on Dec. 19th, at which MR. HAYDN T. HARRISON read a paper on **Some Aspects of Railway Station and Goods Yard Illumination,** followed by a list of the new members of the Society. (Mr. Harrison's paper will be found *in extenso* on pp. 25–32.) After dealing with some of the general considerations to be observed in this class of lighting, the author refers to the work of Mr. Roger Smith, and mentions a rough standard of illumination for railway platforms suggested by him. The position and candle-power of lamps so as to produce a given platform illumination is next discussed, and several useful tables are given, including a comparison of results obtained with different illuminants which the author had prepared from actual measured data. A furthe. table showing the minimum illumination found in sixteen stations of very varying character and methods of lighting is of considerable interest. For lighting goods sheds the author suggests that the most economical system would be one in which the illumination could be varied in any particular part of the shed. The illumination of booking halls and offices is briefly touched upon, and in conclusion it is suggested that a fairly high minimum illumination might be provided, even at small wayside stations, if provision were made for the reduction of the light when no trains were in the station.

At the beginning of the discussion which followed MR. J. S. DOW described some measurements of illumination which he had made on several of the tube railways in London, an account of which appears on p. 33. The figures given serve to show the variations in lighting conditions in the different tubes, and when a station lighted according to the most up-to-date principles is compared with one in which the system of fifteen years ago still remains, the great progress which has been made both in increased intensity and increased efficiency of illumination is clearly demonstrated. Diagrams are given showing the results in the form of illumination curves, and some striking examples of the latest methods of lighting employed, such as the setting of lamps in recesses in the ceiling or the arrangement of screens in front of the lamps over staircases, are mentioned and illustrated. In conclusion, thanks are expressed to the various railway engineers for so kindly granting permission for the taking of measurements and photographs.

Following the official notice of forthcoming meetings of the Illuminating Engineering Society, will be found (p. 43) a brief reference to the unveiling of a statue to Sir George Livesey which took place recently at the works of the South Metropolitan Gas Company.

The number concludes with the usual **Trade Notes** and the **Review of the Technical Press.**

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

A Universal Photometer of Small Dimensions.

By Clayton H. Sharp and Preston S. Millar.

In *The Electrical World* of January 25th, 1908, the writers described an instrument which had been designed for the requirements of the Electrical Testing Laboratories, for a universal portable photometer. Since that time a larger model, embodying the essential features of the first model, but designed more particularly for laboratory work, has been constructed. In the use of these instruments by ourselves and others, it has been found that the larger model (39 in., or 100 cm. long) is eminently satisfactory for high-grade laboratory work, and that the standard model (23 in., or 58 cm. long) is suitable also for much laboratory work in which a bar photometer had previously been employed. The larger model may be used for portable work if desired, although, being designed more particularly for laboratory work, it is rather cumbersome and has a degree of accuracy which is higher than is necessary in most portable work. The standard model has been employed in portable work with much satisfaction, although its accuracy, too, is somewhat higher than is necessary for most field measurements. There is, however, a class of field work in which the accuracy requirements are less rigorous than those which the standard model is designed to meet, and in which portability and convenience of operation are important desiderata. To facilitate such work a new model of the instrument has been built, in which the dimensions have been very materially reduced without any sacrifice in the usefulness of the instrument for this important class of work. Primarily, this model was designed for the purposes of one of us on a journey through Europe during the past summer, where it was desired to obtain some photometric data of reasonable accuracy, but without the effort and difficulty which are required in the operation of the ordinary portable photometric equipment. At the same time the requirements for a field instrument in general illumination work, as ascertained in the use of the standard model, were consulted.

It must be recognized that in a portable instrument observational errors of 2, 3, or 4 per cent may be permissible, while systematic errors averaging 2, 3, or 4 per cent above or below the true value may not be tolerated. In the first case, by taking a number of readings, the true value can be reached; in the second case, essentially false results are obtained. Therefore, in any instrument no matter how great its portability, there must be involved no errors in principle, either of construction or use.

With this accuracy requirement fixed, the smaller model of photometer incorporates the essential features of the larger model, through which accidental errors are minimized and systematic errors excluded.

Description of Small Model.

The length has been reduced to $14\frac{1}{2}$ in. (37 cm.), and the cross-section to $2\frac{1}{2}$ by $2\frac{1}{2}$ in. (6·3 by 6·3 cm.), the linear dimensions having therefore been reduced about one-half, so that the

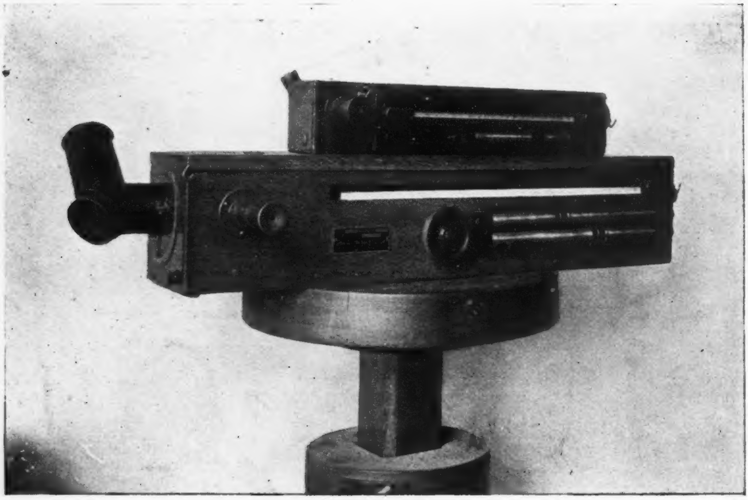

FIG. 1.—Showing relative dimensions of original model and new smaller model.

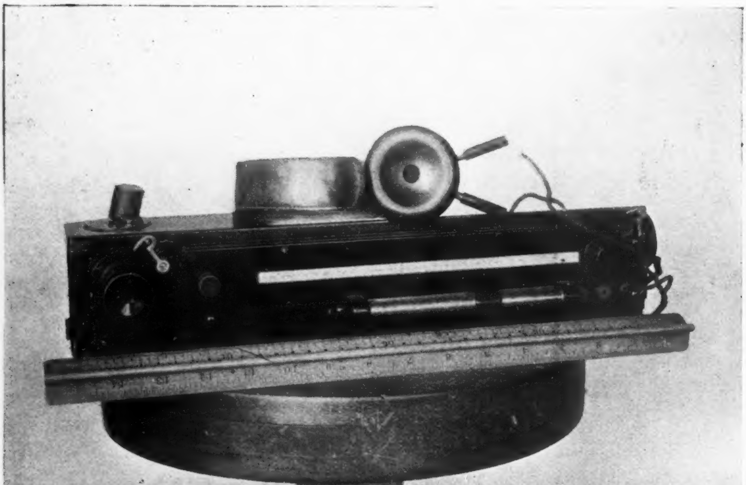

FIG. 2.—Small model of photometer showing telephone receiver employed in regulation of comparison lamp.

volume is only about one-eighth that of the first model. It can be very conveniently carried in a travelling-bag, or even in a capacious overcoat pocket. The scale has been reduced to one-half its former length. In the open part of the scale the accuracy of reading is still greater than the accuracy of setting, so that no loss in accuracy, as compared with the other instrument, has resulted. In the closed part of the scale the accuracy of reading is not so great as the accuracy of setting, so that here a sacrifice has had to be made. The mechanical construction of the instrument has been considerably simplified in its details. The elbow tube carrying the illumination tests plate is placed on the back of the box, in line with the eye-tube.

The troublesome feature in all small portable photometers has been the comparison lamp. If an electric lamp is used, a battery is required, and some instrument for measuring the current passing through the lamp, or for adjusting it to standard value. The alternative for the use of an electric lamp is the use of a small oil or benzine flame. This makes the photometer independent in a way, but involves other troubles which are so serious that in nearly all cases the use of the electric lamp is preferred.

In some cases the use of a measuring instrument has been avoided by calibrating the photometer with a lamp connected directly to its battery, and then relying on the constancy of the battery voltage until such time as recalibration can be made. This method of procedure appears to the writers to be inadvisable, being both less exact and more troublesome than the method where the constancy of the candle-power of a seasoned lamp is depended upon when operated at the measured current. To get results which can be depended upon without the use of an instrument means that a photometric calibration against some standard must be made at very frequent intervals. Also, as is well known, the voltage of a storage battery will run down slowly, even when it is not used at all. This fact makes the use of the photometer dependent upon the availability of a laboratory equipped with suitable measuring instruments and reference standards, where frequent calibrations can be made.

On the other hand, the constancy of a well-seasoned lamp can be depended upon for a considerable period of time, a period which becomes indefinite when the lamp is not in use. It has been customary in the use of the larger model of photometer to employ a precision ammeter for the purpose of adjusting the current. In the smaller model it seemed desirable to find an arrangement which would be lighter and less expensive than a good ammeter; whence the following device, in which the large resistance-temperature coefficient of the tungsten filament is taken advantage of. The lamp is connected so as to constitute one arm of a Wheatstone bridge. The other arms are composed of small coils of manganin wire. Between one lamp terminal and one coil a portion of this wire is extended to form a slide wire, and a scale is arranged to indicate the position of the cursor on this wire. The coils have such a resistance that when the lamp is receiving its proper current, its resistance will be such that the balance-point of the bridge will come within the range of the cursor on the slide wire. Any change in the current flowing through the lamp is accompanied by a corresponding change in its resistance, and the bridge is thrown out of balance. As a convenient means of detecting the point of balance of the bridge, a low-resistance telephone receiver is used. In series with the receiver is an interrupter consisting of a wheel into the periphery of which, pieces of insulating material have been set at frequent intervals. The two bridge arms, which are in parallel with the lamp and its corresponding arm, have approximately five times the resistance of the latter, so that the amount of additional current which they require produces no undue drain on the battery. The telephone receiver is provided with a head band, so that both hands are left free for the operation of rotating the contact wheel and adjusting the external rheostat until a condition of silence in the

telephone is attained. The adjustment of current in this way can be made within about one milliampère, which is substantially the limit of accuracy of reading of a high-grade instrument. Therefore the measurement involves, in the shape of apparatus external to the photometer, only the telephone receiver, which can be readily carried in the pocket if desired.

The optical system has been somewhat changed. In place of the modified Lummer-Brodhun prism as a photometer screen, a circular mirror of thin glass, silvered on the back, with a small round hole cut in the silvering is employed. This mirror is placed at an angle of 45 degrees to the axis of the box, and is viewed through the eye-piece in the ordinary way. The field which is seen looks like the ordinary Lummer-Brodhun field. The elbow tube carrying the illumination test plate is placed on the back of the box in line with the eye-tube. The comparison lamp is a miniature tungsten filament lamp carefully seasoned. The carriage containing this lamp is driven by a cord and pulley arrangement by turning a knob at the end of the box.

Automatically adjustable baffle screens, similar to those employed in the larger models, are utilized, although they are mounted in a simpler and more rigid manner, which permits the instrument to be used in any position without disturbing the operation of the screens.

The translucent scale calibrated in accordance with the inverse square law which has been found so eminently satisfactory in the larger model, has been employed in this model.

For operating the comparison lamp a single small cell or storage battery gives the most constant results ; but, where preferable, two dry cells, which the operator carries suspended on a strap over his shoulder, may be used. As stated above, the instrument was recently carried by one of us on a trip through Europe, and illumination measurements were made with no difficulty on some of the busiest European streets.

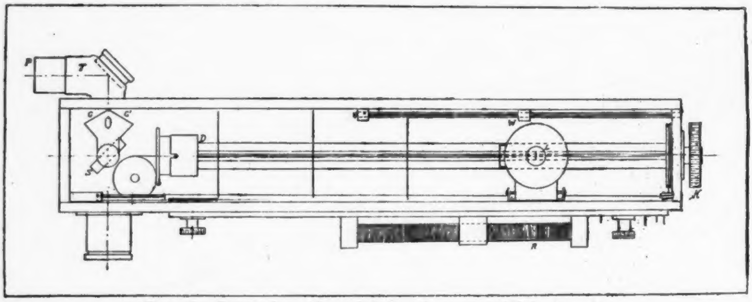

FIG. 3.—Plan of small model showing essential features :—

P.—Reversible tube bearing test plate and diaphragm.
T.—Elbow tube.
G. and G'.—Absorbing screens.
S.—Photometric device.
D.—Diffusing glass.
I.—Interrupter for telephone circuit.
L.—Comparison lamp carriage.
R.—Adjustable rheostat.
W.—Screw driven cursor on slide wire in bridge.
K.—Knob for comparison lamp drive.

CALIBRATION AND USE.

The calibration and use of the instrument are carried out as follows :—

To calibrate with the illumination test plate on the end of the elbow tube, the instrument is set up at such a distance from a standard lamp that the illumination on the test plate is of a known value—for example, one foot-candle. The carriage is set with its index at 1 on the scale. The current through the comparison lamp is then carefully adjusted until a photometric balance is obtained. When this has been done, the cursor on the slide wire is moved until the position is found where the bridge comes into balance.

Thereafter, the cursor does not need to be moved until it is found necessary to make a recalibration.

In the measurement of candle-power the following device is used. The test plate on the end of the elbow tube is itself attached to a short tube which slips into the elbow. At the inner end of this short tube is a diaphragm. The tube may be pulled out and reversed, bringing the diaphragm to the outer end and the test plate to the inner end, thus providing for measurement of candle-power. The tube and diaphragm then serve to exclude stray light from the test plate, and if a lamp

FIG. 4.—Illustrating use of photometer with detached test plate.

is set up at a distance of one foot from this test plate, its candle-power is read directly from the scale, no recalibration of the instrument being required.

In a great majority of cases it is found more convenient to use a detached test plate with this instrument. The detached test plate, which is a plate of white diffusing surface, is placed where the illumination is to be measured, the elbow tube is removed entirely from the photometer, the photometer is held in the hand and pointed at the detached test plate, and the settings are made in the ordinary manner. It is evidently a simpler matter to put the detached test plate in position than it is to arrange a photometer on a tripod, to level it and to get its attached test plate in the required position. Hence this method of operating, though likely to be in some cases less accurate, is in general much quicker and more convenient than the other. Moreover, it frequently happens that illumination measurements are required in positions where it is very inconvenient to get the photometer itself. For instance, the illumination on the backs of a row of books on a shelf may be required. This is readily obtained by fastening the detached test plate at that point and observing it from any required distance. Also the illumination of the ceiling of a room may be desired. The detached test plate can be fastened to the ceiling or can be elevated by means of a pole, and can be observed from the floor. All of these conditions have had to be met with the larger models of this photometer in practical work; with the smaller model they can be more conveniently met on account of the fact that the small model can be held in the hand while observations are being made, and that it requires no levelling or special adjustment. Evidently the calibration of the instrument will be different for the detached test plate from what it is with the attached test plate. That is to say, either the current through the lamp must be adjusted to another value, or the readings must be multiplied by a suitable constant.

Virtually the same procedure serves for the measurement of the specific brightness of any surface. This is a measurement which we have often had to carry out with the other instrument. It is carried out in the same way with the smaller model.

Like the original model, the smaller model is fitted with two absorbing screens for extending its range, so that its total range may be from approximately 0·004 foot-candle to 2,000 foot-candles.

In conclusion, it should be noted that the instrument here described will do nothing which the larger instrument will not do, but that it will do everything that the larger instrument will do, though in many cases with a slightly lower degree of precision. Where a photometer is desired for field work primarily, this model possesses the same superiority which a folding pocket camera possesses over a view camera for tourist purposes. It may be used much more conveniently, and is likely to be used where the larger model would not be used for the reason that the small model may be carried as a part of one's baggage, while the larger model has to be made a separate package, requiring special attention as such.

New Apparatus for the Measurement of Light and Illumination.

By J. S. Dow and V. H. Mackinney.

A little more than a year ago a paper was read by the authors before the Optical Society on a new instrument for measuring illumination, now termed the Holophane lumeter.* Since that time a new model of the instrument, containing several improvements and some accessory apparatus for use with it, has been designed. Some particulars of these (the credit for which is due largely to the ingenuity of the makers, Messrs. R. & J. Beck, Ltd.) may be of interest.

The instrument itself has now the appearance shown in Fig. 1. The chief alteration consists in the use of a circular light chamber. The illuminated aperture has also been slightly enlarged, and by these means the instrument has been rendered more compact without the accuracy being undesirably affected. The dimensions are now only $5\frac{3}{4}$ in. × $4\frac{1}{2}$ in × $1\frac{3}{4}$ in.

Another advantage is that it has been found possible to use a lamp consuming only one-third of the current previously taken, so that the time during which the accumulator can be used without recharging is now considerably greater than before.

Another change has been the placing of the two scales in succession, instead of underneath each other, and the use of a single pointer (instead of one for each scale, as in the old model). At the same time the range of the instrument has been extended. The scale reads up to 2 foot-candles, and dark glasses are provided, which, used separately, multiply the scale by 10 and 100 respectively, and, used together, therefore multiply by 1,000. It is therefore now possible to read up to 2,000 foot-candles, and thus to measure the brightness of many illuminated lamp shades, &c., with a view to testing the "glare."

As regards accessories, the first novelty to be noted is the provision for use of a special Wratten screen, which is mounted in a small cap to be inserted in the front of the instrument, and which makes the colour of daylight identical to the eye with that of the tungsten lamp within the instrument. This is a convenience to those people who find a difficulty in daylight measurements owing to the colour-difference in the photometer screen. As such measurements are usually purely relative, it is not as a rule necessary to take into account the amount of light absorbed by the screen; this quantity can, however, readily be measured once and for all, and allowed for.

The authors have also adapted to the instrument the special daylight device originally suggested by Mr. Trotter, and more recently utilized by Mr. P. J. Waldram.* It will be recalled that the method consists essentially in observing, first, the actual illu-

* *Illum. Eng.*, Lond., Nov., 1910.

* *Illum. Eng.*, Lond., vol., i., 1908, p. 811.

mination in a room, and then the illumination due to a small known fraction of the total sky area. By comparing these readings a factor can be obtained which is independent of the climatic conditions, provided a sky of approximately uniform brilliancy is obtained, and represents the relation between the illumination in the room and the illumination which would be obtained from the unrestricted sky outside. It thus affords a measure of the access of daylight to the room.

The apparatus consists of a small tube attachment having an adjustable aperture at the end pointed to the sky, which is inserted in the tubular aperture at the end of the instrument. It is equipped with the special daylight colour-screen referred to above.

Yet another convenient piece of apparatus is a screen made of the usual ground celluloid material which screws on to a tripod for horizontal measurements. This screen may be mounted in gimbals, so as to take up automatically a horizontal position. It could also be arranged to assume a vertical position, if desired.

The apparatus which will probably prove most interesting to readers of this journal is a new device for obtaining polar curves of light distribution. At the time of his paper on 'The Effect of Wallpapers on Illumination,' last April, Mr. Waldram, at the authors' suggestion, applied the Holophane Lumeter for the purpose of obtaining polar curves of light distribution from a lamp actually in position in a room.* The authors have since devised a form of apparatus embodying similar principles, which simplifies the rather tedious work involved in obtaining such curves.

The apparatus is shown diagrammatically in Fig. 2. It is mounted on a substantial base B the lamp L to be tested being attached to an adjustable rod D, which can be moved up and down or to and fro. When more powerful lamps are to be tested, it may be desirable to remove this arm (which can be done by means of the sliding piece C), and to hang the lamp from the ceiling.

In any case the lamp is brought central with the point E (corresponding with the centre of the polar curve paper shown at K). The rod F rotates about E, and carries the standard celluloid surface G, the distance of which from the lamp tested can be adjusted. As F rotates, therefore, the face of G is always presented vertically towards the lamp L, and its brightness will be proportional to the candle-power of the lamp in that direction. There is also a pointer I rigidly connected with F, which rotates with it and indicates on the sheet of polar curve paper the angle with the vertical which F takes up. It may be added that this paper is arranged to be a convenient height (about 5 ft.) from the ground.

The operation of testing the lamp is as follows: A lamp of known candle-

FIG. 1.—Showing general appearance of new model of Holophane Lumeter (Dimensions: $5\frac{3}{4}'' \times 4\frac{1}{2}'' \times 1\frac{3}{4}''$.)

* *Illum. Eng.*, Lond., vol. iv., May, 1911, p. 20[illegible].

power is first placed in position. The standard surface G is observed through the Holophane Lumeter, and its distance on the rod is adjusted until the reading of the instrument is some convenient sub-multiple of the known candle-power in that direction. (For example, if the candle-power were known to be 16, the reading on the instrument might conveniently be 1·6

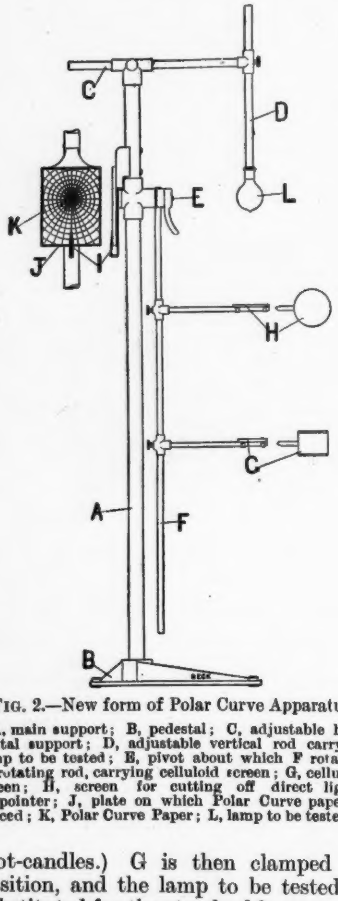

FIG. 2.—New form of Polar Curve Apparatus.

A, main support; B, pedestal; C, adjustable horizontal support; D, adjustable vertical rod carrying lamp to be tested; E, pivot about which F rotates; F, rotating rod, carrying celluloid screen; G, celluloid screen; H, screen for cutting off direct light; I, pointer; J, plate on which Polar Curve paper is placed; K, Polar Curve Paper; L, lamp to be tested.

foot-candles.) G is then clamped in position, and the lamp to be tested is substituted for the standard lamp.

The arm F is then rotated, the brightness of G being noted in each case, and the corresponding candle-power marked on the polar curve paper opposite the pointer. The curve is thus traced out at once, while the experiment is in progress, and there is no need for subsequent calculations.

It is also possible to use this apparatus even in rooms which have not black walls, and in which there is a certain amount of stray light. Under these conditions we make use of H, which is an adjustable black screen, and which can be inserted in any convenient position between the lamp and G. If, therefore, there is any question of the readings being affected by stray light, a reading is taken first *without* H in position. The brightness of G is then proportional to the illumination due to the lamp tested *plus* the stray light (if any). The screen H is then inserted, blocking out the direct light from the lamp tested. The brightness of G is now due to stray light only. Hence, by subtracting the latter reading from the former, we get the true value, *i.e.*, reading without dark screen —reading with dark screen = true candle-power.

The advantages of this method may be summarized as follows :—

(1) The quickness and convenience with which the results are obtained.

(2) The polar curve is worked out automatically while the experiment is in progress; there is no calculation necessary.

(3) The apparatus is simple and portable, and can readily be moved from room to room, which an elaborate photometric bench, equipped with heavy and large mirrors, cannot.

(4) Only one observer is needed for the photometric manipulations, and he can make all the obervations in one position; there is no necessity to be continually crossing the room to adjust mirrors, &c.

(5) By the use of the special screens provided, the apparatus can be used, in an emergency, in an ordinary room without darkened walls, and allowance can be made for any stray light as described above.

It is expected that the apparatus will be most useful for lamps of moderate candle-power (although the fact of the Holophane lumeter reading up to 2,000 foot-candles obviously enables very powerful sources to be tested).

Note on the Measurement of Solid-Angles.

By Prof. Silvanus P. Thompson, D.Sc., F.R.S.

In photometric work the *solid-angle*, or angular space traversed by light, is an important consideration; and occasionally confusion arises from the matter not being so familiar to engineers as might be wished. The scientific way of expressing an ordinary plane angle is to consider the arc subtended in relation to the radius of the arc. That angle—about $57\frac{1}{2}$ degrees, in fact—for which the arc subtended is equal to the radius is called "one *radian*"; and obviously 2π radians equal 360 degrees. But when we pass on to consider solid-angles, we have to think of the angular space which is subtended by an area, as in Fig. 1, in

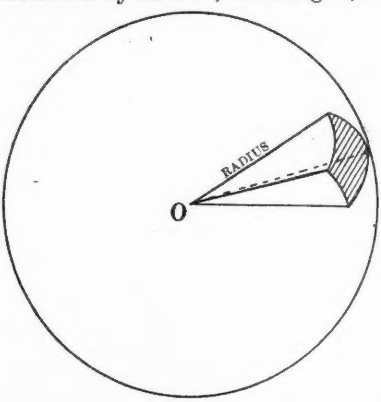

Fig. 1.

which a small quadrilateral area marked out on the surface of a sphere subtends a certain amount of solid-angle at the centre. The value of any solid-angle will be numerically the value of the area which subtends it divided by the square of the radius. That amount of solid-angle which at unit radius is subtended by unit area is called "one *sterean*." Imagine a sphere of 1-in. radius, on the curving surface of which there has been mapped out an area equal to 1 sq. in.: then the solid-angle it subtends is one sterean. Obviously the whole solid-angle of space around any point is 4π stereans. A hemisphere subtends 2π stereans at the centre. But the sterean has the slight disadvantage of being a rather large unit, since the amounts of solid-angle to be expressed in figures is often much smaller than the sterean. For example, the amount of solid-angle presented to us by the apparent disk of the sun is about $\frac{1}{16000}$ of a sterean. A window 6 ft. high by 3 ft. wide subtends only $\frac{1}{8}$ of a sterean at a point 12 ft. away. Hence the practice has arisen of sometimes describing solid-angles in terms of "square degrees." The relation between the square-degree and the sterean is easily found, as follows:—

On a sphere of radius 1 (inch or centimetre, or any other unit of length) the length of 1 degree is obviously $\frac{\pi}{180} = \frac{3\cdot1416}{180} = 0\cdot01745$ (inch or centimetre, or whatever unit is used). Hence the area of one square-degree mapped out on the surface of the sphere will be $\frac{\pi^2}{180^2} = \frac{9\cdot869}{32400} = 0\cdot0003046$ units of area (square inch or square centimetre, &c.). As the radius is unity, this figure therefore represents the value, in stereans, of one "square degree." Or, inversely, one sterean is equal to 3282·8 "square degrees."

In a recent article in *The Illuminating Engineer** from a foreign source it was stated that the solid-angle subtended by a certain window at a point on the surface to be illuminated was "50 degrees." On referring to the original German, it appears that what the author wrote was "50 Quadratgraden"—that is, 50 square-degrees, equal to about 0·015 sterean.

* Vol. iv., Dec., 1911, p. 670.

City of London New Lighting Scheme.

DURING the last month, it is very interesting to observe, the City of London has resolved to adopt a combined system of gas and electric lighting, certain areas being allotted to each illuminant. By the scheme decided upon by the City Corporation (which is subject to slight modification in carrying out the details of area) there will be between 350 and 360 centrally-hung, high-power, electric and gas lamps in the following proportions :—

About 310 electric, 25 of which will be 3,000 c.-p., 12½ amps., Oliver flame arc lamps, with clear globes fitted with dioptric lens, similar to those fitted on suspension gear in Cheapside; these will be used in the Cheapside, Poultry, and Cannon Street area. Owing to the small distance at which the lamps are spaced in Cheapside and Poultry, every alternate lamp will be extinguished at midnight. The remainder of the centrally-hung electric lamps, 11 amps., 2,000 c.-p., fitted likewise with dioptric globe.

The high-power gas centrally-hung lamps (numbering about 40) will be of 2,000 c.-p., of the Cannon Street type, fitted with two inverted burners per lamp.

This will practically sweep away all the obstructive gas columns from the public footways, with the exception of Queen Victoria Street, which is gradually becoming converted to central-post lighting, owing to the large number of rests required in that thoroughfare, caused by the increase in the fast-motor traffic; there will be some 42/2,000 c.-p. high-pressure gas lamps on columns in that thoroughfare. New Bridge Street will also continue to be lighted by the high-power gas lamps as at present, only with 2,000 c.-p. lamps. Mansion House Street will be divided by both companies, who will light it by means of 3,000 c.-p. lamps on the rests in the roadway, whilst the City of London Electric Light Company will light Holborn, Farringdon Street, and Ludgate Circus with 4,000 c.-p. flame arc lamps on tall posts, similar to those at present in use in Farringdon Street.

There will be a few metallic filament (electric) lamps on posts on rests in the roadways where they come near the centrally-hung electric lamps to act as traffic lamps, to keep the vehicular traffic off these refuges.

There will also be some metallic filament lamps on brackets in Paternoster-Row, put up experimentally.

The great benefit to be derived from the new scheme will be understood from the following comparison :—

PRESENT COST OF LIGHTING THE CITY.

	£	s.	d.	£	s.	d.
Gas	10,099	0	0			
Electricity ...	10,774	0	0			
Total ...				20,873	0	0

SAVING UNDER NEW SCHEME.

	£	s.	d.	£	s.	d.
Gas	3,380	0	0			
Electricity ...	3,451	0	0			
Total ...				6,831	0	0

INCREASE IN CANDLE-POWER.

Gas	100·865 c.p.	
Electricity ...	500·890 c.p.	
Total about ...		601·000 c.p.

It appears that in the case of the City of London Electric Lighting Company the Corporation is to have the option of purchasing the lamp standards, brackets, suspension gear, and lamps at the price of £2,000 at the expiration of ten years, if so desired. In the case of the Gas Light and Coke Company the lamp standards, brackets, suspension gear, and lamps become the property of the Corporation at the end of ten years.

The Corporation's "Various Powers Act (1900)" enables the scheme of centrally hung lighting to be carried out, as by it they have full powers to affix to the external walls of any building abutting on a public thoroughfare brackets, pipes, wires, lamps, or apparatus necessary.

Some Tests of the Durability of Drawn Wire Filaments.

SOME tests recently carried out at the New York Electrical Testing Laboratories, and described at a meeting of the American Illuminating Engineering Society, demonstrate clearly the superior filament strength of modern drawn wire lamps.

A special device was constructed for the purpose of testing the lamps, and may be described as follows. The lamp is mounted on an arm which, at every revolution of a cam, is brought up to a constant position, and then allowed to drop freely on to another cam. This second cam is of spiral construction, and is arranged so that the drop can be uniformly increased from 1-100 in. to 4 in., the exact fall being read off on a dial directly in hundredths of an inch.

The results shown in Table I. were obtained in this way.

TABLE I.

Type of Lamp.	Distance Lamp was dropped.	Type of Lamp.	Distance Lamp was dropped.
25-watt	0·06 inches	25-watt	3·75 inches
60-watt	1·15 inches	60-watt	A fall of 4 inches failed to break the filament.

A carbon lamp remained unbroken with the maximum fall.

Some further tests reported at a meeting of the Association of Iron and Steel Electrical Engineers in America, are of interest. In these tests the lamps were placed upon a rack hinged at one end, and arranged so that the lamps would drop periodically on a solid surface from heights varying from 6 in. to 24 in. A 100-volt drawn-wire filament lamp withstood 3,697 shocks on this testing device without breaking.

Yet another extensive series of tests has been conducted during the past year by the United States Navy to determine the serviceability of drawn-wire lamps when in use on warships.

Table II. gives an interesting summary of the results obtained on board battleships from the period from November, 1910, to July, 1911.

It is suggested that lamps which can successfully withstand target practice are suitable for any kind of service on board ship. Drawn-wire Mazda lamps were used in all the above tests, for the particulars of which we are indebted to the British Thomson-Houston Co.

TABLE II.

Size of Lamp used.	Number of Lamps installed.	Average life of Lamps.	Lamps broken during target practice.	
			Number.	Percentage.
25-watt	375	755 hours	12	4
40-watt	842	1155 „	28	3
60-watt	36	1677 „	1	0·3
400-watt	8	1386 „	—	—
500-watt	9	2563 „	—	—

Coming Lectures on Illuminating Engineering.

Regent St., and Battersea Polytechnics.

THE last of the initial series of six lectures delivered during the present year at the above two institutions was delivered by Dr. W. Ettles at Regent Street Polytechnic on Tuesday, December 5th, on 'Illumination and the Eye.' The courses will be continued at 7.30 P.M. on Thursdays and Fridays respectively early in the new year, when the remaining six lectures will be delivered by Mr. J. S. Dow.

The first six lectures dealt mainly with various artificial illuminants; the rest are to deal with the measurement of light and illumination, shades and reflectors, practical problems in illumination, &c.

The first of the remaining series (on 'The Measurement of Light') will take place at Regent Street Polytechnic on Thursday, January 11th, and at Battersea Polytechnic on Friday, January 12th, 1912.

Northampton Polytechnic Institute.

The series of lectures on 'Illumination' previously announced to take place at the Northampton Institute, will be given on Tuesdays at 7.30 P.M., the opening lecture (on January 16th) being by Mr. S. D. Chalmers, M.A., on 'The Nature of Light and Radiation.'

Special Advanced Course of Lectures on Illumination at University College, London.

It is with great pleasure that we observe the announcement of a special course of advanced lectures on 'Illumination and Photometry, to be given by Prof. W. C. Clinton, B.Sc., A.M.I.E.E., at University College (Gower Street). This course is to take place on Wednesdays at 6.30 P.M., the opening lecture being on Wednesday, January 10th, 1912.

The course is to consist of eight lectures, and is addressed to those who have already some practical acquaintance with modern lighting problems and requirements, and are desirous of extending their knowledge of the physical principles underlying the subject. Laboratory work in illustration of the course will be arranged for a limited number of students after some of the lectures, and the fee for the complete course will be 2 guineas.

The subjects of the lectures are as follows:—

I. The Nature of Light.
II. Radiation and Matter.
III. The Sensation of Light.
IV. The Production of Light.
V. Photometry.
VI. Photometers.
VII. Illumination from a Single Source.
VIII. Interior and Exterior Illumination.

It is very gratifying to see that University College—where so much work on the subject of photometry has already been carried out under the supervision of Prof. Fleming—has taken the lead in organizing an advanced course of this description. Prof. Clinton it may be added, like the lecturers in the courses referred to above, is a member of the Illuminating Engineering Society, and we feel sure that this series will be of interest to many others belonging to the Society.

Application for tickets of admission is to be made to THE SECRETARY, MR. W. W. SETON, UNIVERSITY COLLEGE, GOWER STREET, LONDON.

Indirect Lighting by Arc Lamps.

ON Wednesday, December 6th, a paper on the above subject was read by Mr. J. Eck before the Electrical Contractors' Association, the meeting being held in the house of the Institute of Sanitary Engineers. Mr. Eck laid himself out to impress on electrical contractors the many applications of arc lamps, illustrating his remarks by a series of excellent lantern slides of various

indirect lighting installations. Figures were quoted for the consumption of electricity, the costs of installation and maintenance for sizes of rooms, and the illumination in foot-candles. Special stress was also laid by the author on value of the indirect system in distributing the light to all parts of a room, the absence of glare, and the fact that soft shadow, but not a "shadowless" illumination was obtained.

The results of some experiments intended to show the pleasant nature of the illumination for eyesight were next given. The author contended that letters of a certain size could be read by the aid of smaller illumination when glare was absent, and that lighting by indirect arc lamps possessed this particular advantage to a high degree.

Mr. W. R. Rawlings, the Chairman, briefly congratulated Mr. Eck on his paper, pointing out the value of information on illumination to electrical contractors. In this connection he alluded in complimentary terms to the work of the Illuminating Engineering Society, and called upon its Hon. Secretary, Mr. L. Gaster, to say a few words.

Mr. Gaster also congratulated Mr. Eck on his lucid and interesting paper, and on the scientific methods adopted in supporting his contentions. He also wished to make special reference to the admirable series of illustrations thrown upon the screen, which, he understood, were due to the photographic skill of Mr. T. E. Ritchie. He concluded by assuring electrical contractors that the Illuminating Engineering Society would welcome their support. He hoped that many of them would follow the example of Mr. Eck and their Chairman by becoming members, and issued a cordial invitation to them to be present at meetings of the Society.

The proceedings then closed with the usual vote of thanks to the lecturer.

Method of Running Glow Lamps on Low-Frequency Circuits.

It is found that when glow lamps are run on an alternating circuit, if the frequency falls much below 50 cycles per second, the fluctuations are sufficiently slow to become visible. Hence, unless some special device to mitigate this defect is used, a traction circuit with a frequency of 15 cycles per second would be unsuitable for glow lamp lighting.

A method of overcoming this difficulty is described in a recent number of *La Revue Électrique*. It consists in using two lamps in the same globe (or two separate filaments in the same lamp), one being connected direct across the circuit, and the other having an inductive resistance or condenser in series with it. This causes the current in the second filament to lag or lead by about 90 degrees, and, in consequence, the current in one filament will always be at a maximum when the current in the other is at a minimum, thus tending to equalize the lighting effect of the combination and to eliminate fluctuations.

Another method is to put an inductive resistance in series with one lamp or filament, and a condenser in series with the other; by this means the two currents can be made equal. In any case a difference of phase of approximately 90 degrees is required.

Northampton Polytechnic Institute.

Annual Prize Distribution and Conversazione.

At the Annual Conversazione of the Northampton Institute, which took place on Friday, December 8th, the prizes and certificates for the year were presented by Sir William H. White, and the laboratories and workshops of the Institute were thrown open to visitors. There were also a series of interesting demonstrations arranged, including that by Mr. T. D. Wright on 'Electric Clocks,' and Mr. C. L. Redding on 'The Human Eye.'

Electric Lighting of Railway Trains: the Brake-Vehicle Method.

By Roger T. Smith, B.Sc., Assoc.M.Inst.C.E.

Abstract of a paper read at a meeting of the Institution of Civil Engineers on Tuesday, Nov. 28th, 1911.

The method of train-lighting considered is that in partial use on the Great Western Railway, where axle-driven dynamos and batteries controlled by an automatic regulator are installed on brake - vehicles only. The lamps throughout the train are supplied from these equipments, which work in parallel with each other, the brake-vehicle equipments and the lamp wiring in the coaches dependent on them being connected electrically by through wiring coupled between coaches. There is consequently an appreciable reduction in initial cost and upkeep of plant, and what is of chief importance from the railway point of view, increased reliability.

The first aim of any method of train-lighting should be to light passenger rolling-stock adequately and with reliability. Measurement and experience lead to the provision of an illumination, measured on a horizontal plane at eye-level, of 2 foot-candles in 3rd class, and 2½ foot-candles in 1st class compartments. Glare or dazzle can be minimized, if not entirely prevented, by keeping lamps out of the line of sight, by providing a white background behind the glowing filament, or by reducing the intrinsic brilliancy of the filament by enclosing the lamp in a diffusing or Holophane globe, the latter at the same time improving distribution. The tungsten train-lighting glow lamp now replaces the carbon glow lamp, its most economical efficiency with present train-lighting lamps being 1·3 watts per candle. On the average, tungsten glow lamps, with a useful life of 850 hours, now have to be changed only once a year in the electrically-lit coaches on the Great Western Railway, where lamp voltage is regulated within 2½ per cent.

Any axle-driven system must in the first place provide a lead-cell or other accumulator, so that the lamps are lit whether the train is standing or moving throughout its range of speed. In order to draw proper attention to the importance of the accumulator in train-lighting, it is both convenient and useful to look upon the accumulator as the essential element and on the dynamo as a device for making the output of the accumulator continuous throughout the hours of lighting. As typifying the accumulator, the lead cell alone is considered. The two extremes among methods of charging lead cells are charging at constant voltage and charging at constant current, but a method of charging which combines the advantages of both extremes, while avoiding their disadvantages, is recommended, the charge being completely under the control of an automatic regulator set to give the proper compromise. The arrangement consists in starting with a heavy charge and gradually reducing it until, after proper gasing has taken place so as to mix the electrolyte, the charge is stopped when the cells are full, or the battery is left floating on the load while lights are on. Automatic regulation is necessary to secure a long and healthy life for the lead cell, and to reduce maintenance it is essential; when properly arranged, 10 per cent per annum of the initial cost of the whole cell will provide for both maintenance and renewals of the plates and boxes.

The train-lighting dynamo is of secondary interest as compared with the battery, the essential element being some means of keeping the voltage constant at all speeds while permitting of its automatic variation by the

regulator when required. The automatic cut-in cut-out switch for connecting or disconnecting the dynamo from the battery should be actuated electrically, since the voltage of the latter may vary 25 per cent from that of the former at any given speed. It is desirable that this switch should also act as an instantaneous automatic reverse-current circuit-breaker. The functions of an ideal regulator, combining in one or two instruments battery and lamp-voltage regulation, may be defined briefly as the following: First, it must control the lamp-voltage within $2\frac{1}{2}$ per cent of the rated voltage of the lamps, and, within reasonable limits, must do so independently of lamp-load and entirely independently of battery-voltage. Secondly, when lamps are off, the regulator must control the generator-field so as to provide the full output of the dynamo for charging an empty battery; and when lamps are on, the balance of the full output must be available for charging. As charging proceeds, the regulator must control the inherent regulation of the dynamo, so that its voltage only rises sufficiently to give a diminishing charging current. Thirdly, with a fully charged battery and lamps off, the regulator should reduce the charging current to zero. Fourthly, with a fully charged battery and lamps on, the dynamo output must be adjusted to equal the lamp load, leaving the battery in a floating condition, with current neither entering nor leaving it. The foregoing requirements can to-day be obtained combined in one piece of apparatus.

To reduce the initial cost of electric train-lighting it is of first importance to reduce the number of battery-cells, since within train-lighting limits it is the number of cells to be maintained, and not their size, which counts. The number of dynamos and regulators may be reduced in the same proportion. With the exception of through coaches transferred from main to branch lines, every train on the Great Western Railway has at least one brake-vehicle controlling it for traffic purposes, and all coaches which leave or join a main-line train *en route* are either brake-vehicles themselves, if detached or attached as single vehicles, or, if two or more coaches are detached or attached, they are controlled by a brake-vehicle. If every brake-vehicle is equipped with a generator and battery, the remaining coaches being wired only, while through wiring and couplers, designed to connect all vehicles together electrically, are provided on every coach, a less costly method of lighting trains is assured, as compared with the equipment of every coach as a self-lit vehicle. In addition, much greater reliability is secured by working two or more dynamos and batteries in parallel. This arrangement of equipment it is proposed to call the "brake-vehicle" method, because under ideal circumstances only brake-vehicles need be equipped. On the assumption that all Great Western passenger rolling-stock might be equipped for electric train-lighting, the percentage of brake-vehicles would be 27, of dependent coaches 40, and of self-lit coaches 33 for main-line working; while for local and suburban traffic the percentage of brake-vehicles would be 39, and of dependent coaches 61. If the ratio of brake-vehicles to dependent coaches were as 1 to 3, and there were no self-lit coaches, the initial cost of equipping an entire rolling-stock of some thousands of coaches would be reduced by about 35 per cent as compared with self-lit equipments, and the working-costs would be reduced about 40 per cent. The increased reliability due to a higher percentage of generator coaches is, however, of greater importance to the railway than reduction in cost. In addition to the electrical requirements already specified for the ideal equipment, others are specially needed for the brake-vehicle method. It is of primary importance that the dynamo should be capable of running with its brushes short-circuited, while in addition its output must be capable of being quickly altered by a simple adjustment to suit altered traffic conditions.

An experimental six-coach train lit on this method was run nearly continuously for two years in all sorts of traffic, varying from fast main-line services to slow, stopping, local services.

Two brake-vehicles, equipped with 45-ampere dynamos, regulators, and 180-ampere batteries, light themselves and three dependents. A self-lit detachable coach completes the train. The Leitner system provided the only available apparatus able to meet the special conditions. All the equipments are in parallel, coupled through cables throughout the train providing for this. For the lighting circuits the through wiring and method of coupling is arranged on the loop-positive system, one regulator controlling the lamp-voltage on each side of the loop. The same looped-positive brake-vehicle method has been applied to two trains running on South Wales services, to two new trains specially built for the Cunard boat service between Paddington and Fishguard, and to two new trains used for Birmingham local services; and it is being further applied. The bus-bar system of through wiring, a simplification of the looped-positive system, is now being adopted. By the bus-bar system greater simplicity and increased reliability are secured as compared with the looped system, but at greater cost.

The total annual cost of lighting a six-coach train on the looped-positive brake-vehicle method is as follows. The cost of the initial equipment would be £761, inclusive of all carriage-work charges; adding working costs, extra cost of locomotive-power—determined experimentally—and capital charges, the total annual cost becomes :—

	£
Working costs	45
Power to drive dynamos, 1½ per cent on £875	13
Haulage of extra weight, 1·7 per cent on £875	15
Interest on £761 at 4 per cent ..	30
Reproduction of capital in 20 years at 3 per cent	23
Total annual cost of lighting a six-coach train	£126

With regard to the safety of electric train-lighting, although at 22 volts an arc can be formed between any of the metals employed in train-lighting, this arc will not persist. Provided the ordinary precautions necessary with electric circuits are taken, and suitable fuses are used and properly maintained, it is believed that complete immunity from fire risks can be ensured.

Allowance for the Reflection from Coloured Wall Papers.

We have received from a German correspondent a copy of a little brochure issued by the Deutsches Luxfer Prismen Syndikat of Berlin, which contains some tabulated data on the amount of light reflected from wall papers. When prismatic glass is fitted into a window with the object of improving the daylight illumination, for example, it must be remembered that, although much of the light enters direct and falls straight on the tables, &c., another portion will strike the walls and only reach the tables after reflection. In designing such window space therefore, or in fitting glass to existing windows, it is necessary to allow for the effect of absorption from the walls.

The publication referred to contains a numbered series of twenty samples of paper, ranging from the lightest yellows to dark slaty grey. In each case the percentage of light absorbed and the multiplying factor to be used in calculating the necessary window space, is given.

The following are the data for some of the chief tones :—

Colour.	Percentage of Light Absorbed.	Multiplying Factor.
Dark red	80 per cent	1·94
Light red	57 ,,	1·58
Orange	35 ,,	1·23
Yellow	24 ,,	1·06
Green	76 ,,	1·88
Blue grey (dark)	90 ,,	2·10
Blue grey (medium)	76 ,,	1·88

The table affords an interesting example of the appreciation of the need for scientific study of these effects of reflection from the walls of interiors.

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

(The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.)

The Lighting of Railway Stations and Goods Yards.

(Proceedings at a meeting of the Illuminating Engineering Society held in the House of the Royal Society of Arts (London), on Tuesday, December 19th, 1911.)

A MEETING of the Society was held on December 19th, 1911, Mr. F. W. Goodenough (Chairman of Council) being in the chair.

The minutes of the last meeting having been taken as read, the CHAIRMAN called upon the Hon. Secretary to read again the names of applicants for membership presented at the previous meeting, who were then formally declared members of the Society.* The names of applicants for membership received since the last meeting were also read out for the first time.

THE CHAIRMAN then called upon Mr. Haydn T. Harrison to read his paper on 'Some Aspects of Railway Station and Goods Yard Lighting.' (This will be found *in extenso* on page 25.)

At the commencement of the discussion which followed, MR. J. S. DOW described some measurements of illumination which he had carried out on the London tube railways, and threw on the screen some tables and diagrams showing the results obtained and several photographs of stations, &c. (See page 33.)

MR. ROGER T. SMITH (Great Western Railway) said that the figure of 0·25 foot-candle for minimum illumination attributed to him by Mr. Harrison really only applied to large terminal stations, and he thought it might be extravagant if applied to all types of station. The use of small units placed low was satisfactory, except that it was then more difficult to avoid glare. He thought that more consideration should be given to lighting the roofs in large stations.

MR. FRANK BAILEY did not think they need fear too high a standard of illumination, and thought 0·25 foot-candle might be stipulated as a minimum for all stations. He thought a "mixed" system of illumination, in which large units, such as flame arc lamps, were supplemented by small units for local lighting, might be found satisfactory.

MR. BURGESS (Midland Railway) thought it was important for measurements of horizontal illumination always to be made at the same height from the ground. He gave some figures he had obtained for a high-pressure gas installation with inverted mantles, and mentioned a case in which special lighting was needed for shunting in a goods yard.

MR. HERBERT JONES (London & South-Western Railway) suggested that local illumination should always be provided at ticket barriers. He pointed out that there were two distinct classes of station—those that were entirely roofed, in which case flame arc lamps served very well, and those that had separate roofs for each platform, in which case he would use tungsten lamps and reflectors. He exhibited a slide to show the even illumination which had been obtained in the new booking-hall at Waterloo Station.

MR. A. P. TROTTER thought that a system of "mixed" lighting would mean reduced efficiency, and referred to the importance of *vertical* illumination

* See *Illum. Eng.*, vol. iv., Dec., 1911, p. 682.

in such places as goods yards, where labels and other marks had to be deciphered.

MR. GROVE (Central London Railway) described how their arc lighting had been replaced by the use of high candle-power tungsten lamps, a particularly good result havng been obtained at the stations where Holophane reflectors were installed. The light on a platform should be sufficient for a man to read his paper, and also should light the advertisements well. The outside lighting of a station was often made very brilliant purely to attract the public, as, for example, at the Oxford Circus Station.

MR. SEVERN (Great Northern & City Railway) said they had abandoned opal shades above their pendant lamps in favour of open Holophane bowls. In this way advantage was taken of the reflecting power of the tiles in the roof.

MR. J. G. CLARK mentioned a comparison he had made of upright and inverted mantle gas lighting, in which, although the maximum and minimum values of the illumination in each case were practically the same, the saving in gas by the use of inverted mantles was between 40 and 50 per cent.

THE CHAIRMAN thought that small units might be used on the score of economy, but that the suggested minimum of 0·25 foot-candle was rather high—at any rate, for small stations.

MR. HARRISON, in a brief reply, pointed out how closely Mr. Dow's results for tube stations agreed with his own. He also agreed that more attention might be given to lighting the roofs of stations. With regard to the suggested minimum, he thought that this might be provided temporarily (while a train was in) even at small stations. He disapproved of a standard of *average* illumination.

A vote of thanks to Mr. Harrison having been carried with acclamation, the CHAIRMAN announced that the next meeting would take place on Tuesday, January 16th, 1912, when a paper would be read by MR. T. E. RITCHIE on 'Colour Discrimination by Artificial Light.' The members then adjourned to the library for tea and coffee.

NEW MEMBERS OF THE SOCIETY.

The names of the applicants for membership, read out at the previous meeting on November 17th, were formally announced for the second time, and these gentlemen were declared Members of the Illuminating Engineering Society.*

In addition the names of the following gentlemen have been duly submitted and approved by the Council, and were read out by the Hon. Secretary at the meeting of the Society on December 19th:—

Vice-President :—

Abney, Sir William C.B., D.Sc., F.R.S.	Adviser to the Board of Education, Member of Advisory Council for Education to the War Office (1903), late President of Royal Astronomical Society, Physical Society, &c. Rathmore Lodge, South Bolton Gardens, London, S.W.

Corresponding Member :—

Bertelsmann, Dr. W.	Chemist to the Municipal Gas Works, Berlin, Waidmannslust, near Berlin.

Members :—

Aston, J. E.	Acetylene Lighting Engineer, 25, Denmark Street, London, W.C.
Bailey, F.	Chief Engineer, City of London Electric Lighting Co., Ltd., 64, Bankside, S.E.
Dixon, H. L.	Chief Engineer, Leatherhead and District Electricity Co., Ltd., Bridge Street, Leatherhead.
Herbert, Major D.	Old Bank House, Sherborne, Dorset.
Ryland, H. S.	Optician, 9, Vere Street, London, W.
Jackson, H.	Electrical Contracting Engineer, 19, Berners Street, London, W.
Cotton, H. F.	Superintendent of Public Lighting, Corporation of Dublin, 74, Mirrion Road, Bullsbridge, Dublin.

* *Illum. Eng.*, Lond., Dec., 1911, p. 268.

Some Aspects of Railway Station and Goods Yard Illumination.

By Haydn T. Harrison, M.I.E.E.

(Paper read at a meeting of the Illuminating Engineering Society held in the House of the Royal Society of Arts (John Street, Adelphi, London), on Tuesday, December 19th, 1911.)

Members of this Society cannot have failed to notice the large differences which exist between the degree of artificial illumination in various railway stations. It is, of course, understood that stations vary in importance, depending on the extent and class of traffic dealt with, but it is not an uncommon thing to come across two stations of equal importance in which the artificial illumination of one may be ten times that in the other.

It naturally follows that either one is extravagantly lighted, or the other is not sufficiently illuminated.

Since engineers who have made a study of illumination have been appointed to some of the important railway companies in this country, it is noticeable that they have in many cases raised the standard of illumination; on the other hand, by far the majority of stations are still illuminated to the same low standard that existed ten or twenty years back.

To the author the position of railway station lighting appears to be much the same as that of street lighting, namely, that no standard has ever been agreed upon. As regards street lighting, this is now being dealt with by the Street Lighting Standards Specifications Committee, on which this Society is well represented. There is little doubt that valuable work would be done if the Society, either by discussion on this paper or other means could come to some conclusion as to the minimum illumination desirable for railway stations of various classes.

As the degree and system of artificial illumination of railway stations affects the safety of the public, it is surprising that the Board of Trade has never found it necessary to formulate regulations concerning it; but I think this is accounted for by the fact that other operations necessarily carried out in stations make it essential that the minimum illumination should exceed that which might be called the danger-point as regards the public. It is unlikely, for instance, that people could fail to see the edge of a platform even with a degree of illumination as low as moonlight, say, ·002 foot-candles; whereas I have come across few examples where the illumination is less than ·01, though cases as low as this are numerous.

In passenger stations the platforms are used for many purposes which require a comparatively high degree of illumination, such as examining tickets, luggage labels, recognition of faces, inspection of time-tables, notices, &c., all of which operations have to be carried out rapidly and with precision in order that time, so important a factor in railway work, shall not be lost.

It must be borne in mind that the acceleration of traffic in order to meet with the public requirements is always an object receiving the careful consideration of railway engineers, and as it is at the stations where trains stop that much time is often lost, more particularly at night, the author ventures to suggest that if some of these stations were better illuminated, the time spent at them would be proportionately reduced.

The cost of artificial lighting has been much reduced during the last few years by the introduction of improvements both in gas and electric lamps, but it is surprising how little those improvements have been taken advantage of by the railway companies. Station after station will still be found lighted by means of flat-flame gas burners or

at the best, upright mantles; whereas the inverted mantle has numerous advantages for this class of work. With electric lamps we still find the open-type arc lamp, of which the efficiency is very low compared to modern flame arc lamps or even tungsten incandescent lamps suitably arranged. It is true that capital would have to be expended in making the necessary improvements, but this would soon be wiped off by the saving effected, and the greatly improved illumination would be obtained without increased cost. In the case of some of the important railway companies in this country, lighting-engineers have been appointed who are dealing with these improvements, and it is to these engineers we must look for valuable data as to results, &c.

Mr. Roger Smith, whose knowledge and experience on this subject is unique, in a paper he has lately read before the Institution of Civil Engineers, gave it as his opinion that "the minimum illumination (midway between two lamps) 4 ft. above a railway platform need never exceed ·25 foot-candles, and the maximum under the lamp ought not to exceed 2 foot-candles, unless it is to appear poorly lit, and it is partly for this reason that the value mentioned has been decided on."

This opinion, emanating from the source it does, is extremely valuable, but it is a pity that Mr. Roger Smith did not give the other part of the reason for choosing this figure, because, if ·25 foot-candles is the lowest to which one can go before the appearance of a poorly lit station is reached, it is obvious that a higher standard would be necessary for what might be considered a well-lighted station. Another point requiring careful consideration when dealing with this opinion is the height at which the illumination is taken compared with the maximum illumination. For example, if a station platform were lighted with lamps 12 ft. from the platform level, *i.e.* only 8 ft. above the photometer, the candle-power directly below these lamps must not exceed $2\,(12-4)^2$, or 128 c.-p., otherwise the illumination will exceed the maximum proposed. I heartily agree with Mr. Roger Smith in this respect but would point out that the same lamps if placed 60 ft. apart, would have to give over 400 c.-p. at the 20 degrees (from horizontal), in order to obtain ·25 foot-candles minimum. This profile of lighting is, of course, easy to obtain with some types of lamps, but impossible with others.

In the case of one station I tested, lighted by high-pressure gas lamps 80 to 90 ft. apart and 13 to 14 ft. high, the minimum illumination was ·25 foot-candles, but the maximum 4·0, thus demonstrating that the type of lamps should have been placed higher; whereas another example, using tungsten electric lamps in suitably designed lanterns between 14 and 15 ft. high and 50 ft. apart, gave 0·3 minimum and 2·0 maximum, thus being well within the limits laid down by Mr. Roger Smith.

It is, of course, possible to keep within the tenfold limit suggested with nearly any type of lamp provided the height of the station roof will allow of the lamps being placed high enough, and in the case of termini and other large stations, this is generally possible; but in the case of large junctions and stations, where each platform is provided with its own roofing, this is, of course, impossible, and smaller light units placed close together must be used. This leads up to the relative efficiency of large or small units of light for the purpose of railway station illumination. I have therefore prepared a table showing the total candle-power necessary to produce definite illuminating results; but, before discussing this on the basis of figures, it would be well to consider the relative sizes of units from the point of view of convenience.

Every railway station can be taken as an area occupied by platforms and rail bed, the former only need be illuminated, as any stray light reaching the permanent way sufficiently illuminates it.

The platforms are generally only in use when trains are standing at them; therefore, it is often customary to considerably reduce, if not altogether dispense with, the illumination when any platform is not in use. This, of

course, can be done where each platform is treated separately; but if the station as a whole is lighted by means of very large units, it becomes difficult. Moreover, much of the light from large light units is wasted in lighting the permanent way, which is unnecessary; therefore the use of light units giving more than a certain candle-power is uneconomical in every respect.

Taking platform lighting as the illumination of a long, narrow area, and the degree of illumination at the edge of that area as being the most important, it follows that if a centre row of lamps be used, the light from them must be such that the illumination derived from any one lamp must be sufficient to light the edge of the platform adjacent to it. It follows from this that the most economical arrangement of lamps would be that at which they are spaced at a distance apart equal to twice the width of the platform.

Thus, in the case of a platform 30 ft. wide, the lamps would be 60 ft. apart, and to give a minimum horizontal illumination equal to ·25 foot-candles 3 ft. from the platform level would have to give 400 c.-p. at 20 degrees if placed 13 ft. high, taking the maximum illumination as 2 foot-candles. The height could be arranged to suit the vertical candle-power of the lamps which would be as given in Table I.

TABLE I.

Effect of height on profile curve of lamp in order to produce ·25 ft. candles minimum and 2·0ft. candles maximum horizontal illumination 3 ft. above platform level.

Height of lamp above platform	Angle below horizontal.	Candle Power	Maximum permissible vertical Candle-Power.
13 feet	18°	400	200 c.-p.
15 „	22°	345	290 „
20 „	30°	295	570 „

The above figures are taken for lamps arranged 60 ft. apart.

The profile curves of lighting of various types of light sources are sufficiently well known to illuminating engineers to enable them easily to decide on the height of any type. For example, if low-pressure inverted gas mantles were used, they would have to be erected between 15 and 20 ft. above the platform level; the same would apply, of course, to the ordinary pattern of flame arc lamp. On the other hand, vertical incandescent gas mantles or tungsten lamps could be placed as low as 13 ft. from the platform level. It is not always possible to follow this rule of spacing owing to constructional features of a railway station, supports and other obstructions; these often necessitate that the lamps should be arranged at distances apart which result in the minimum of shadow; but in this case the writer advocates quite a different system of lighting, namely, that the pillars or roof supports should be surrounded by the lamps themselves. This practice has not been generally adopted, it being more common to erect or suspend the lamps between the supports, which unfortunately results in the minimum illumination being halved in the shadow of the support. This shadow cannot be avoided where large units of light are used, but in nearly every case it will be found more efficient to abandon the large units of light and erect small units of light round the supports themselves, taking care to use efficient reflectors, which does away with all fixed shadows and results in a higher minimum illumination efficiency.

In order to make a comparison between the relative illuminating value of high and low candle-power units, it is necessary to take a definite length of platform into consideration; therefore, in the following table, this has been put at 1,000 ft. The height of the lamps is stated as the height above the photometer screen, which must be added to the height mentioned in order to calculate the height above the platform.

It naturally follows that the width of the platform which would be illuminated to the minimum extent is equal to half the distance between the lamps. Thus, in the case of A, for example, this would be 10 ft., or 5 ft. on either side of the line of lamps.

A general analysis of the above table goes to show that when the distance apart of the lamps exceeds 60 ft.,

and it is intended to use high candle-power lamps, these must be at least twice as efficient as the smaller units in order to obtain the same results at the same cost. For instance, supposing examples A, B, C, and D were carried out by means of low-pressure gas mantles or tungsten electric lamps, therefore the electric flame lamps might be favourably considered under Scheme I., but in order to get satisfactory results and keep the extremes of illumination within the prescribed limits, it would be necessary to use high-current lamps with dioptric or similar light deflecting globes.

TABLE II.

Total C.P. required to obtain ·25 ft.-candles minimum horizontal illumination with lamps of various powers, and ratio of same.

Index.	Distance apart.	Height.	Angle F. Minimum point.	C.P. of Lamps.	Total C.P. per 1000 feet.	Ratio.
A	20 feet	10 feet	45°	35	1750	1
B	40 „	10 „	27°	138	3450	2
C	50 „	10 „	22°	237	4750	2·7
D	60 „	13 „	23°	400	6666	3·9
E	80 „	15 „	20°	650	8125	4·65
F	100 „	15 „	17°	1200	12000	6·86
G	100 „	20 „	22°	1000	10000	5·7
H	140 „	20 „	16°	2375	16960	9·7
I	140 „	25 „	19°	2050	14600	8·3
J	200 „	25 „	14°	5500	27500	15·7
K	200 „	30 „	17°	4700	23500	13·4

and E, F, G, and H by high-pressure gas mantles or flame arc lamps, the latter would have to be twice as efficient as the former at the angles of light mentioned; but, on the other hand, if it were possible to utilize method B with the former, and G with the latter, the 1,000 c.-p. lamps would need to be nearly three times as efficient as the 140 c.-p. incandescent lamps.

Taking that, with gas, the high-pressure mantles give 60 candles per cubic foot against 20 to 30 for the low-pressure mantles, it is obvious the low-pressure mantles would be the more efficient system.

In the case of electric light, where, with tungsten lamps and suitable reflectors, it is possible to obtain 1·5 candles per watt at the angles mentioned, whereas with flame arc lamps, unless of very high candle-power, 2 to 2·5 candles per watt at an angle of 17 degrees is rarely exceeded. The use of flame arc lamps would not compare favourably with the tungsten lamps; on the other hand, six candles per watt can be obtained with the higher candle-power lamps;

As proof of these statements I have actual examples of stations before me, illuminated by these various systems, which, when brought down to a common basis, work out as follows:—

TABLE III.

Type of Lamp.	Distance apart (average).	Watts per 1000 ft. of Platform.	Minimum illumination (average).	Watts per ft. candle per 1000 ft.
Open type Arc	100 ft.	7500	·1	75000
Flame Arc Lamp	90 „	3650	·25	14600
Large Current Flame Arc with Dioptric Globe	72 „	9700	1·25	7800
Tungsten Lamps	50 „	6000	·45	13300
„ „	25 „	12000	2·0	6000

It will be noted that these figures, which are the average of several independent measurements, clearly bring out the economy of using comparatively small units of light, and also that if large units of light are used, special dioptric globes are necessary.

It must also be borne in mind that

cost is not only affected by the consumption of gas or electricity, but also by the relative cost of renewals, labour, &c., which is considerably higher with high-pressure gas lamps or electric flame arc lamps than is the case with low-pressure gas or tungsten electric lamps.

At various times the author has had the opportunity of making illumination tests at a large number of stations of varying importance, the results of which are interesting as indicating the condition prevailing at the present time. These results are set out in Table IV.

be congratulated on the excellent results; especially good are the stations where 100 c.-p. tungsten lamps, with obscured lower parts, are used, suspended in large opal glass shades. Not only is the average minimum illumination good, namely, ·3 foot-candles, but the maximum, which was generally found to be 2·5, is not excessive, and there is no doubt that the cost is very moderate, as the total candle-power or watts per 1,000 ft. of platform is about 3,500, and the consumption of energy is comparatively low. As the sources of light on tube stations must

TABLE IV.

Test Lines.	Class of Station.	Type of Lamps in Use.	Average Minimum horizontal illumination.
1	Large Main Line Station ...	Low pressure Gas upright Mantles ...	·015 foot-candles
2	" " " " ...	High Pressure Gas	·07 "
3	" " " " ...	" " "	·12 "
4	Main Line Terminus	" " "	·2 "
5	" " "	Flame arc lamps	·5 "
6	" " "	" " "	·25 "
7	" " "	" with special globes	1·26 "
8	" " "	Ordinary open arcs	·08 "
9	" " "	Tungsten lamps	1·25 "
10	" " Station	" "	·05 "
11	Main Line large Junction ...	Inverted gas	·1 "
12	Suburban Station (average) ...	Upright mantles	·05 "
13	Underground Tube Stations...	Enclosed arc lamps	·24 "
14	" " " ...	Tungsten lamps	·38 "
15	" " " ...	" "	·18 "
16	" " " ...	" "	·28 "

It will be seen from the above results that it is impossible to obtain any definite idea of railway engineers' requirements as to the minimum horizontal illumination. For example, the station mentioned under Test 1 deals with more traffic than that mentioned under Test 5. Example No. 7 is up to standard mentioned by Mr. Roger Smith, and there is no doubt it is sufficiently lighted, but it is gloomy compared with Station 5, where the higher minimum is gained by placing the lamps closer together.

It will be noted that the tube stations are much more consistent, and I think it will be agreed that they are, generally speaking, amply illuminated. There is every evidence that considerable care has been exercised in illuminating the tube stations, and I think the engineers responsible are to

necessarily be placed low the use of any high candle-power lamp would be disadvantageous, but I am surprised that more advantage is not taken of the excellent reflecting properties of the glazed white walls which predominate in some stations.

The Lighting of Goods Sheds.

This is a very similar proposition to that of passenger stations, with the exception that the minimum illumination must be sufficiently high to allow of labels being easily and quickly read. This means that any illumination below 0·25 foot-candles causes delay in handling the goods; but, of course, this degree of illumination is only necessary at the parts where the goods are being handled, therefore an economical system would be one by which the illumination could

be varied at any particular part of the shed. The general structure and conditions prevailing in goods sheds varies considerably, thus making it necessary to treat each case separately.

The illumination of shunting yards and open goods yards is, in the author's opinion, a case where large units of light are essential; these should be erected as high as possible. For example, a 12-amp. flame arc lamp provided with dioptric or similar globes erected on a mast 50 ft. high, will cover an area of 125 ft. radius with a minimum horizontal illumination of ·1 foot-candles, or, where the light from two meet, a radius of 160 ft. is possible. This means that lamps at 100 yds. apart would give a minimum illumination considerably higher than is generally required. On the other hand, the maximum illumination would not exceed 0·5 with lamps of this type at the height mentioned. Under these circumstances it is doubtful if any better means of lighting shunting yards could be adopted, but stress must be laid on the fact that in order to obtain these results correct distribution of the light is essential, and in the case of most lamps, this can only be obtained by adopting correctly designed globes and reflectors.

Illumination of offices, Booking Halls, &c.

As the illumination of these embodies the same features as many other problems already discussed and dealt with by this Society, I do not propose to deal with it here, but rather to confine this paper to that section of illumination in connection with railway systems which is peculiar to railway work.

In order that some decision may be come to on degrees of illumination required, it is necessary to take into consideration the various purposes for which the illumination is required; but before doing so, I should like to call your attention to a very valuable paper on this subject read before the Institution of Mechanical Engineers in 1906 by Mr. Henry Fowler, in which he lays great emphasis on avoiding "the fault of patchiness"—in other words, keeping the limits of illumination within reasonable bounds. In a paper read before the Institution of Electrical Engineers, I called these limits the "diversity factor" of illumination; this term was adversely criticized, but as no better has been suggested, I am afraid I must adhere to it. This diversity factor in railway station lighting is particularly noticeable. For example, it is not uncommon to see a ticket inspector walk towards a lamp in order to inspect a ticket; this time would be saved if the minimum illumination was sufficient for the purpose, and therefore that should be one of the factors taken into consideration.

It is, of course, admitted that in small stations tickets are only examined at the barrier, and in such cases Mr. Fowler suggests "that all that is necessary is to provide sufficient light to prevent accidents"; but I think, even in small stations, the illumination should be sufficient to allow luggage labels to be deciphered and faces to be recognized; therefore, it is doubtful whether a limit below ·1 foot-candles should be permissible.

Another feature which enters into railway station illumination is the class of passengers who use the station. For example, in a highly respectable village, with few exceptions, the passengers are all well known to the station officials; on the other hand, in a factory district, thousands of men and women, all of one class and very often of similar appearance, use the stations night and morning, hurrying to and from their work; in these cases a higher standard of illumination is necessary, at any rate at those times.

These local conditions, affecting, as they do, the degree of illumination necessary, make the task of fixing on any definite standard for the various classes of stations a difficult problem; nevertheless, it emphasizes the fact that if the degree of illumination was capable of being varied by the local officials to meet the exigencies of the moment, nearly perfect conditions would result, as the local officials are generally in a position to know the exact requirements at all hours of the

night. Under these circumstances, I would suggest that, even in unimportant stations, a minimum of ·25 foot-candles should be obtainable when all the light is turned on. This variation in candle-power should, if possible, be controlled from one point, and if the limits were arranged from ·25 to ·05 foot-candles, all requirements would be fulfilled at a low cost, provided the arrangements were such as to reduce the illumination in proportion to the electricity or gas used.

In reading a paper before this Society one naturally avoids any invidious comparisons between the competitive illuminants; but, while on this subject of control of illumination, it is necessary to mention that in the case of gas mantles it can, I believe, only be effected at the cost of efficiency unless, of course, the mantles are grouped in lanterns piped in such a way as to allow of gas being turned off from mantles in each group, and even then the use of by-passes often affects the saving adversely. In the case of electric lamps it is easily accomplished without loss by running three wires instead of two. In the case of either illuminant it is not economical to turn out intermediate light sources, as the reduction of illumination is then out of all proportion to the reduction in cost.

When dealing with railway station lighting the illuminating engineer will find that the ordinary lay man—by which I mean the man not versed in illuminating problems—will nearly always show a preference for lamps having opalescent globes well filled with light. Lamp makers have known this for some time, as is demonstrated by the dense opalescent globes often supplied with flame arc lamps, and if such globes are installed, though the actual minimum illumination may be lower, the lay man will give it as his opinion that the lighting is better, and even engineers are often misled into thinking that the useful candle-power of the lamp is higher.

I have in my mind an actual example of this, where in one case the maximum illumination was 4 foot-candles, and the minimum ·3; whereas, when this was compared with a type of lamp which gave a maximum of 2·75 and a minimum of ·45, many gave it as their opinion that the illumination was preferable with the former, thus showing that they could not realize the importance either of diversity factor or minimum illumination upon both of which Mr. Fowler and Mr. Roger Smith and myself lay considerable stress.

It may be suggested that the attractiveness of highly opalescent globes enclosing high candle-power lamps is due to the reduction in glare; but it must be borne in mind that glare can be avoided by more economical means than dense globes. For instance, raising the height of the lamps out of the line of sight, or by providing them with suitably designed reflectors, which prevent the naked lamp being seen except against the well-illuminated white surface of the reflector. Again, in the case of tungsten electric lamps or similar lamps, the partial obscuring of the lower part of the bulbs or globes, as is done on the Tube stations, will not only prevent glare, but also produce more even distribution of light.

In conclusion, I will attempt to sum up the points which require careful consideration when dealing with this subject. As all railway stations are used for similar purposes, though in different degrees, it would seem that the standard of illumination should be similar; but, as in many stations the service does not demand this degree of illumination, except at rare intervals, means should be installed by which the cost of lighting such stations is reduced not by lowering the degree of illumination, but by ensuring that it can be easily varied to a low standard when the platforms are not in use.

From this it follows that, with the exception of very important termini or stations where a frequent service demands it, it is advisable to adopt comparatively small light units in order that each platform may be dealt with separately, and the light reduced when any platform is not in use. It is to be hoped that the discussion on this paper will lead to some standard

of illumination being decided upon, and I think that the thanks of this Society are due to Mr. Roger Smith for having suggested such a standard. I also wish to take this opportunity of thanking him for the very valuable data he so kindly put at my disposal, and to say how much I regret that he was unable to collaborate with me in submitting this paper, as I am certain that, had he been able to do so, it would have been of some considerable value ; whereas, as it stands at present, I can only hope that it will be of use in opening up the subject, with the object of promoting a useful discussion, during which, I trust, the railway engineers will give us the benefit of their experience and their opinions as to the requirements of railway station illumination.

[Since writing this paper, the report of a Committee on Illumination presented before the Association of Railway Electrical Engineers in Chicago has been issued, and an abstract of this occurs in *The Electrical World* (Dec. 2nd), from which I may quote a few passages which are of interest in connexion with this paper:—

Yards.—The properties of a lamp chosen for this class of work should be good distribution, reliable action, and a colour of light suitable for penetrating smoke, fog, &c. The flame lamp, with its penetrating yellow flame and high efficiency, lends itself admirably for the purpose. The development of the long-life electrodes has added an impetus to the adoption of this type of lamp. Large-type tungsten-filament lamps are now developed that, used under suitable reflectors, are also useful for this class of work. The unit should be suspended high in order to avoid decreasing the ability of the eye to see and to eliminate shadows between cars.

Train Sheds and Platforms.—A general illumination is required of sufficient intensity to afford convenience to passengers in passing to and from the trains, and to enable conductors and trainmen to inspect the tickets, and also to facilitate the handling of baggage.

Because of the prevailing high ceilings of train sheds, the lighting has been confined principally to the larger units such as arc lamps. However, since the development of the high-efficiency incandescent lamp in large sizes we may expect a goodly share of this class of lighting to go to the incandescent lamps. In low-ceiling sheds relatively small units located between tracks give better results from the standpoint of light distribution and consequent avoidance of shadows.

Freight House and Platform.—The requirement for this class of lighting is low general illumination, sufficient to discharge or load and sort the various classes of freight. This may be accomplished best by incandescent lamps, the type of lamp being governed by the height of roof truss. In most cases the high-efficiency incandescent tungsten filament lamp will be found best adapted, and this should be equipped with suitable reflectors and suspended close to the ceiling. For buildings with high ceilings, where the lamps may be hung at a height sufficient to eliminate objectionable glare and also secure proper distribution, the flame or luminous arc-lamp may be used to good advantage. Where there are receiving and shipping desks or tables these can be lighted by means of drop lights, consisting of small-candle-power lamps equipped with metal reflectors. These reflectors should be of such shape as to screen the lamp filament from the clerk's eyes.

The lighting of platforms is accomplished to best advantage by means of small-candle-power incandescent lamps. These units should be equipped with metal reflectors, and suspended either from wall bracket arms on the side of the shed or else from the roof where the platforms are covered by projecting eaves. The intensity of illumination required for this class of work is about the same as that necessary for the interior lighting of freight houses.]

Discussion.

The Chairman, before opening the discussion, explained that a series of tests had been made on the underground railways by Mr. J. S. Dow, and he thought it would be convenient for those present to have these figures, which were supplementary to Mr. Harrison's paper before them, as

TABLE 1.—ILLUMINATION, DATA FOR TUBE RAILWAYS.

Railway.	Method of Lighting.	Width of Platform.	Height of Lamps.	Distance between Lamps.	Consumption watts per square foot.	Illumination between lamps. Average	Min.
		Approx. feet.	Feet.	Feet.	Watts. sq. ft.	Foot-	candles.
Great Northern & City Moorgate Street	Enclosed arcs 6 amp. dense outer globe 5 in series on 550 v.	10	9½	40	1·5	1·9	0·6
"	Bare Tantalum 100 watt lamps and opal shades	10	8½	25	0·45	2·6	0·8
Old Street	Holophane hemispheres, 220 watt Tantalum lamps ...	8	9½	25	1·1	1·6	0·9
Central London Chancery Lane	Enclosed arcs, 5·5 amps., 5 in series on 550 v....	10	10	65	0·9	1·0	0·3
British Museum	Holophane Reflectors and 100 watt Tungsten lamps	10	10	24	0·4	1·2	1·05
Piccadilly & Brompton Piccadilly Circus	Opal hexagonal shades and 125 watt frosted Tungsten lamps ...	10	13	30	0·4	1·1	0·4
Charing Cross & Hampstead S. Kentish Town	"	10	13	35	0·35	0·7	0·25
City & S. London Bank	Enclosed arc lamps (5 amp., 4 in series on 500 v.)	12	10½	40	1·25	3·5	1·0
Kennington	Bare 100 c.p. Tungsten lamps without shades	10	9	24	0·5	0·75	0·45
Oval	Bare Tantalum 50 c.p. lamps (2 in series) without shades ...	10	8½	40	0·25	0·35	0·1
Waterloo & City Waterloo	Tungsten 55 watt lamps with enamelled reflectors, placed at inside of platform	12	9	12	0·375	0·6	0·35

FIG. 1.—Moorgate Street Station (Great Northern and City Railway), lighted by Tantalum Lamps and opal shades.

FIG. 2.—Old Street Station (Great Northern and City Railway), lighted by Holophane Bowls.

further material for discussion. He had therefore much pleasure in calling upon Mr. Dow to present these data.

Mr. J. S. Dow said that at Mr. Gaster's suggestion he had visited several railways and made measurements of illumination which, it was hoped, would be of interest to the Society. Up to the present he had confined himself to the tubes, but hoped eventually to supplement these data by figures for other railways. It was most interesting to see how keenly the question of illumination was now being taken up and how active railway engineers were in making experiments on lighting. He proposed to bring some of these developments before the notice of the Society, and hoped that this data would be useful to those engaged in railway illumination, and would be of assistance in establishing a standard for platform lighting. He wished to make it clear, however, that he was not attempting a general comparison of the advantages of different systems of lighting, as this would entail a far more detailed study of the circumstances than could be presented in the tables about to be shown.

The measurements of illumination were made with the Holophane lumeter instrument in a horizontal plane 40 in. (approximately 1 metre) above the platform. The figures given were taken underneath the lamps (which, in the case of tube railways, practically corresponded with measurements near the edge of the platform—the most essential part to receive good illumination); as a matter of fact, however, the readings near the side of the tube were usually not very noticeably different from those at the centre of the tube, owing to the reflection from the tiled surface.

The speaker, presenting Table I., pointed out that the minimum illumination was (with one exception) above 0·25 foot-candles, which afforded an interesting confirmation of Mr. Harrison's suggested standard minimum (0·25 foot-candle). It might also be noted that the figures given for the tube stations using opal hexagonal shades and tungsten lamps were very close to those mentioned by Mr. Harrison (namely, a maximum of about 2·5 and a minimum of about 0·3 foot-candle) for a similarly lighted station. It should, however, be recalled that in tubes running all day the hours during which lamps had burned soon mounted up, and he understood that it was by no means infrequent for metallic filament lamps to burn for 4,000–5,000 hours. Consequently some latitude in the measurements of illumination must be allowed, higher results being naturally obtained in the case of a new installation. The figures for the consumption were necessarily to be regarded as approximate. They were calculated in terms of the area of platform lighted. It might, however, be argued that the lamps were also needed to light the rails, and in this case a breadth of about 18 ft., instead of 10 (the usual breadth of the platform), must be allowed, and the watts per square foot reduced accordingly. The central positions usually assigned to lamps in the tubes naturally meant that a very considerable amount of light fell on the rail bed. Presumably, this was desirable on the tubes, but he noticed Mr. Harrison had stated that very little light was needed for this purpose. It would be interesting to hear the views of railway lighting engineers on this matter. Another point to be noted was that a certain amount of light should be allotted to the sides of the tube, in addition to the platform. It would be noted that there was a striking difference in the consumption of electricity for the two systems used at the Moorgate Street station on the Great Northern and City Railway. This tungsten lighting was only used for the "short-train" service, the arc lamps being used for normal conditions. The effect of the tungsten lamps and opal shades was to throw the greater part of the light on the platform, but to leave the upper part of the tube in comparative shadow. Moreover, he was inclined to suggest that the bare tungsten lamps, placed at the comparatively low height of 8½ ft., had a somewhat glaring effect, and thought the newest method of lighting employed at Old Street an improvement in this respect.

This question of special lighting for short-train service was interesting as illustrating the local circumstances to be taken into account in judging lighting conditions. Again, the long platforms in use on this line had been designed with a view to longer trains from other services eventually running through on to the Great Northern and City line. Meanwhile, however, it was only considered necessary to illuminate strongly the part of the platform on which the tube trains drew up. One other special point he might mention. Visitors to the tubes would notice the line of lamps on the platform wall, apparently additional to the general lighting. These lamps were in the nature of a safeguard, being run off a set of mains from the local electric supply company, and entirely independent of the railway circuit. In the event of a breakdown of the railway generating station, therefore, this emergency lighting would always be available.

Several slides were next thrown upon the screen, showing the method of illumination of the Moorgate Street and Old Street stations on the Great Northern and City line, the British Museum station on the Central London Railway, the Bank, Kennington, and Oval stations on the City and South London, and the Piccadilly Circus station on the Piccadilly and Brompton Railway. In the latter case an interesting novelty was the placing of a lamp in a recess in the ceiling, so as to illuminate the end wall of the tube without the actual lamp being visible to people on the platform; this was intended mainly for ornamental effect, and to prevent the impression produced of the station "having no end to it."

FIG. 3.—Piccadilly Circus Station, lighted by opal shades and Tungsten lamps. Note the special illumination of end wall of tube by concealed lamp in a recess in roof.

The closer distance of the enclosed arc lamps at the Bank (City and South London) station, as compared with those at Chancery Lane, had a marked effect on the illumination, the minimum

Fig. 4.—BRITISH MUSEUM STATION (Central London Railway),

Lighted by Tungsten Lamps and Holophane Reflectors.

Average illumination, 1·2 f.c. } Watts sq. ft., 0·4.
Minimum „ 1·05 f.c. }

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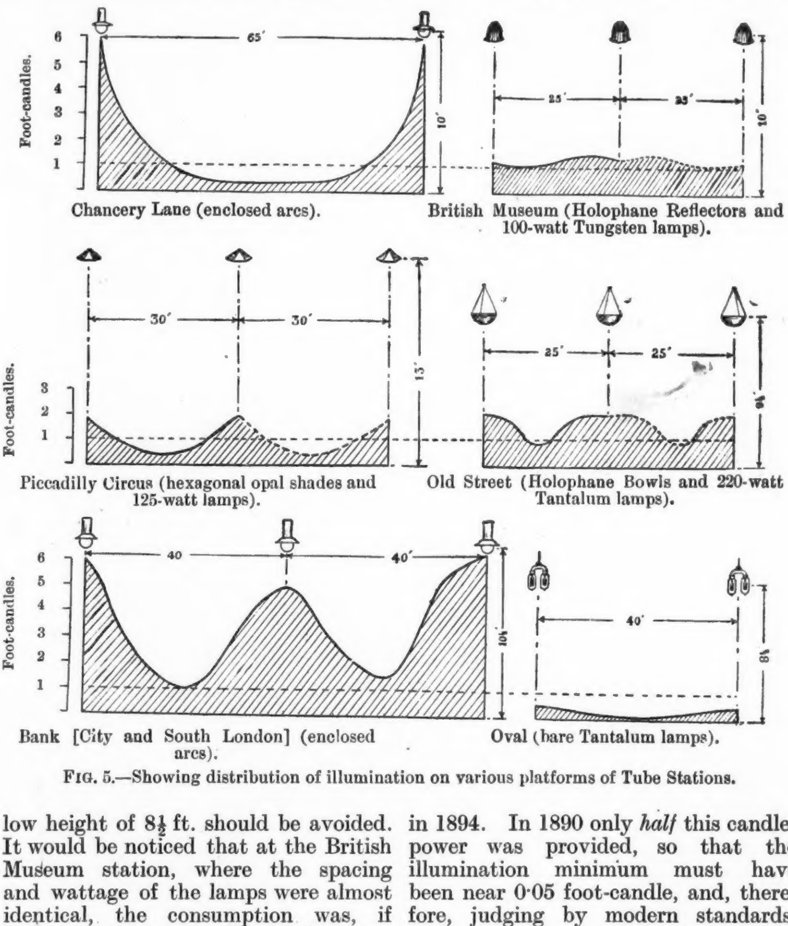
value being 1 foot-candle instead of 0·3.

At the Kennington station a series of naked 100-watt tungsten lamps without any shades were employed, it being presumably considered that the white tiled walls were sufficient to diffuse the light. However, he thought that the presentation of unscreened filaments at the comparatively



Chancery Lane (enclosed arcs).

British Museum (Holophane Reflectors and 100-watt Tungsten lamps).

Piccadilly Circus (hexagonal opal shades and 125-watt lamps).

Old Street (Holophane Bowls and 220-watt Tantalum lamps).

Bank [City and South London] (enclosed arcs).

Oval (bare Tantalum lamps).

Fig. 5.—Showing distribution of illumination on various platforms of Tube Stations.

low height of 8½ ft. should be avoided. It would be noticed that at the British Museum station, where the spacing and wattage of the lamps were almost identical, the consumption was, if anything, slightly less than at Kennington, and the results seemed much better both from the standpoint of uniformity and with a view to the avoidance of glare. This improvement suggested the benefit of using appropriate reflectors.

At the Oval, where doublets of 50 c.-p. tantalum lamps are employed (without reflectors) 40 ft. apart, the illumination was naturally considerably below the average. He understood that (except for the substitution of metallic filament lamps for carbon ones) the lighting was practically identical in intensity and arrangement with that employed on all the stations in 1894. In 1890 only *half* this candle-power was provided, so that the illumination minimum must have been near 0·05 foot-candle, and, therefore, judging by modern standards, very dim. Yet he was informed that the newspapers of that time considered it brilliantly lit by comparison with what had been usual before. On the City and South London Railway, which was, of course, the earliest tube

to be constructed in London, other interesting historic parallels might no doubt be established illustrating the great advance in the general standard of illumination during recent years. A comparison of the illumination of the stations lighted with enclosed arcs (of which the Bank is typical) with those illuminated to the Oval standard suggests that the illumination has apparently increased about twenty times since 1896.

FIG. 8.—Showing new method of lighting passages at Piccadilly Circus Station (Piccadilly and Brompton Railway). The lamps are concealed in whitened slots in the roof.

MR. DOW next showed a diagram (Fig. 5) illustrating the distribution of illumination secured on these railways by different methods. The latest

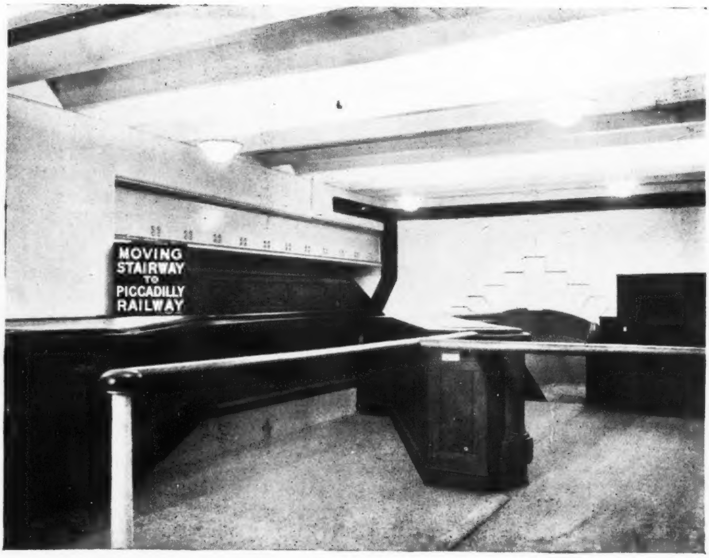


FIG. 6.—Earl's Court Station; top of Escalator lighted by inverted opal fixtures and Tungsten lamps. Average illumination over 1 foot-candle. Consumption 0·6 watts per square foot.

FIG 7.—View looking up Escalator. The lamps are screened by horizontal ground glass slabs so that people descending do not see the source of light. The staircase was moving when this view was taken, and the steps (at the sides) therefore cannot be seen.

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method employed on the Great Northern and City Railway at Old Street (lighted by Holophane hemispheres) gave a much more uniform result than that obtained by the enclosed arcs (as at present arranged) at Moorgate Street, while the illumination secured by the tungsten lamps and Holophane reflectors at British Museum gave a nearly uniform value of 1 foot-candle. These data would be interesting to Mr. Harrison in connexion with his suggestion that uniform illumination could most readily be obtained by grouping small units near together. Another simple means of promoting uniformity, the indirect method, would be dealt with shortly. It would be observed that the uniformity of the lighting by the hexagonal opal shades and frosted lamps at Piccadilly Circus was also fairly satisfactory, and he wished to echo Mr. Harrison's commendation of this system with a view to avoiding glare. The installation at the British Museum station was also good in this respect, and, indeed, a conspicuous feature of the methods of lighting being introduced in the tubes was the attention paid to this matter.

The speaker then went on to say that by the kindness of the engineer of the London Electric Railways permission had been granted to take some measurements and photographs on these lines, and he had an opportunity of inspecting some of the very latest installations. The series of slides prepared showed some most interesting features. He understood that an arrangement had recently been made to place the lighting on an entirely distinct circuit, independent of that feeding the trains, and thus avoiding the inconveniences of running lamps in series on the naturally somewhat variable traction pressure of 550 volts. Alternating current was now being transmitted at 220 volts and transformed down to 60 volts at each station. (In addition, there were, of course, the usual emergency lights run off a third entirely distinct circuit from the local electric supply company, as mentioned above.)

The first of this series of illustrations showed the method of illumination by indirect opal fixtures and tungsten lamps at the top of the "escalator" at Earl's Court (Fig. 6). The resultant illumination was very soft, and he was assured by Mr. Brook, the engineer of the company, who had kindly taken him round, that absence of glare, with a view to avoiding accidents, was one of the main features to be kept in mind in all future installations. The illumination near the top of the "escalator" varied from about 1·2 to 1·8 foot-candles. The minimum value recorded in this part of the station was about 0·5 foot-candle. The consumption of electricity worked out to about 0·6 watts per square foot. He thought those present would agree that this was a most picturesque and interesting method of lighting.

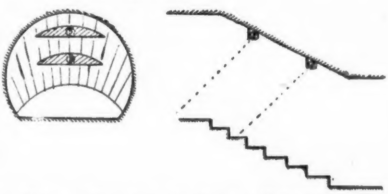


FIG. 9.—Showing shading of lights from the eye in old passages, to which the slot method (shown in Fig. 8) cannot be applied.

The escalator (the moving staircase carrying people up from the tube) led down from the point seen at the back of this illustration. The next view (Fig. 7) was a view of the escalator taken from the foot, looking upwards. The lighting of the staircase was again of a novel specially designed character, being again specially designed with a view to avoiding glare and enabling passengers to pick their steps conveniently in embarking on the staircase (which is about 60 ft. long and 12 ft. wide). The lighting was accomplished by a series of nine obscured glass horizontal plates let horizontally into the ceiling, and each carrying two 28-watt lamps. The consumption was thus about 0·7 watt per square foot. The average illumination on the stairs was about 0·5 foot-candle.

The essential points to be noted were: (1) That the light was adequately softened so as to cause no inconvenience to the eyes of people ascending; and

(2) that people descending could not see the sources of light at all. Experience had shown that it is mainly when *descending* stairs that people are apt to stumble, and the lighting was therefore contrived so that glare was impossible in their case. From the standpoint of avoidance of glare the method seemed an admirable one, and a combination of architectural features and lighting was a thing that the Illuminating Engineering Society had strongly advocated. There was one suggestion that might be made. Would

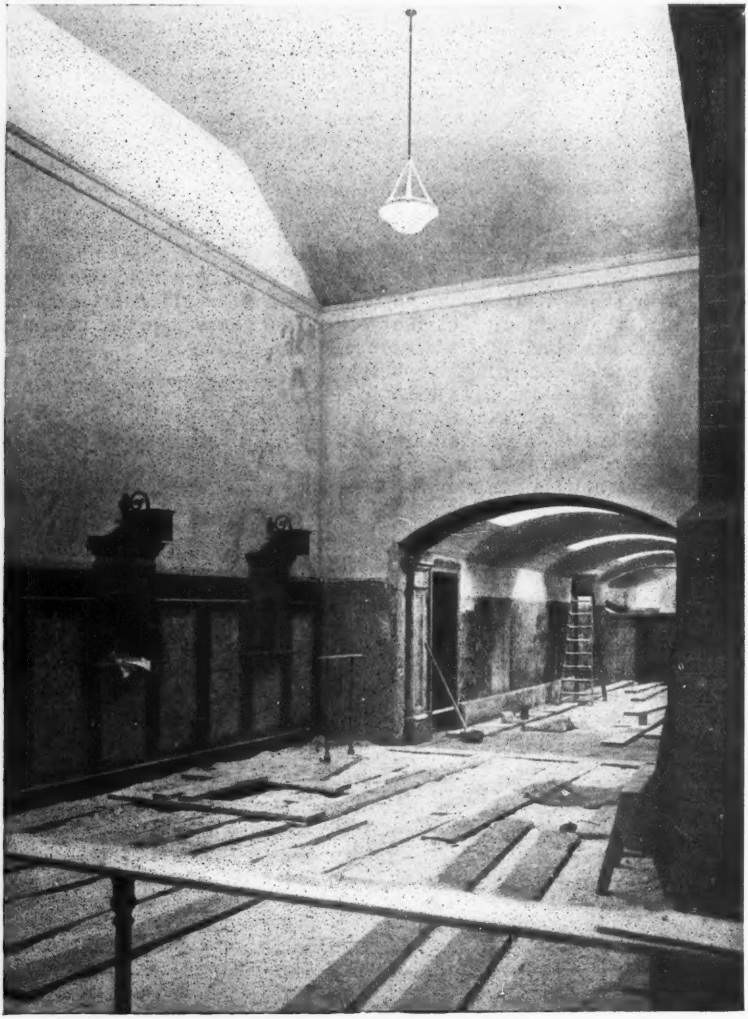


FIG. 10.—New Booking Hall at Golder's Green Station (not yet open to the public). The average illumination is about 0·5 foot-candle, and the watts per square foot 0·4 (approx.). In the background may be seen a passage lighted in the manner shown in Fig. 8.

it not be a good thing to accentuate the lighting in some way at the top and foot of the stair so that people's attention was automatically drawn to the rising or falling step as they commenced ascending or descending respectively? This was the point at which, if anywhere, people might be expected to stumble.

The next illustration (Fig. 8) showed one of the very newest passages at Piccadilly Circus, the lights being concealed in slots in the ceiling. This was again an illustration of the good principle of designing illumination and construction *together*. The minimum illumination at the foot of the stair was about 0·5 foot-candle. This method, he understood, was being employed on all the new passages designed. On the existing passages (without ceiling-slots) another method of screening the lights to downward passengers descending the stairs (shown diagrammatically in Fig. 9) was being experimented with.

In conclusion, two views of Golders Green station were shown. The first of these referred to the new booking hall (not yet open to the public). The illumination was again by semi-indirect opal-tungsten units, and the illumination on the floor at the time of test varied between 0·4 to 0·6 foot-candle, thus showing the usual good uniformity characteristic of well-designed indirect systems. The consumption of electricity was about 0·4 watt per square foot (very approximate). The lamps were placed at a height of 15 ft. (estimated). In the background of the illustration would be seen a passage lighted on the new recessed system. The final illustration was a photograph of the outside of the station as seen by night, making an attractive picture and illustrating the value of light for advertising purposes.

FIG. 11.—Showing outside of Golder's Green station by night.

In conclusion, MR. DOW expressed, on behalf of himself and Mr. Gaster, their great indebtedness to the kindness of the railway officials and the engineers of the various companies mentioned, who had granted facilities for these

tests to be carried out and taken a great deal of trouble in this direction. Acknowledgment was also made of the services of Mr. V. H. Mackinney, who had kindly accompanied the speaker when these tests were made and taken the series of admirable photographs (entirely by artificial light) used to illustrate these data.

[The further Discussion of Mr. Harrison's paper, and his reply, will be published in our next number.—ED.]

Official Notice of Next Meeting.

THE next meeting of the Illuminating Engineering Society will be held at the House of the Royal Society of Arts (John Street, Adelphi, London, W.), at 8 P.M. on **Tuesday, January 16th, 1912,** when a paper will be read by **Mr. Thomas E. Ritchie, A.M.I.E.E., A.M.I.Mech.E.,** entitled **Colour Discrimination by Artificial Light.** (SOME NOTES ON THE CHANGES IN THE APPEARANCE OF COLOURED OBJECTS WHEN VIEWED UNDER VARIOUS ARTIFICIAL LIGHTS.)

Members desiring to join in the discussion are invited to send in their names to the Hon. Secretary (MR. L. GASTER, 32, VICTORIA STREET, LONDON, S.W.) beforehand, and an advance proof of the paper will be forwarded to them.

At the following meeting on February 20th, 1912, it is anticipated that the subject of Shop Lighting will be dealt with, and the names of authors will be announced in due course.

Annual Dinner.

The Annual Dinner of the Society will be held in the month of February. Full particulars of time and place will be circulated amongst members shortly.

Unveiling of Statue to Sir George Livesey.

ON Friday, December 8th, Earl Grey unveiled the statue of Sir George Livesey by Mr. Pomeroy, to which we have previously made reference.* In doing so he alluded to the great work of Sir George Livesey in connexion with co-partnership and the great services rendered by him to the gas industry.

His qualities as an organizer and leader, his administrative ability, and knowledge of human nature have received grateful recognition from many outside his immediate sphere of influence. His memory has also been honoured in the gas industry by the creation of the Livesey Professorship at Leeds University, where so much good work is already being undertaken.

* *Illum. Eng.*, vol. iii., 1910, p. 432.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Welsbach Lamps for Train Lighting.

There is probably no firm in the world that is better equipped for and is a larger supplier of gas lighting specialities to railway companies than the **Welsbach Light Company, Ltd.** (Welsbach House, King's Cross, London, W.C.). Their supplies extend from the smallest bijou mantles for use in railway carriages up to the biggest high-pressure gas installations (of the well-known Pharos system) for lighting railway stations, goods yards, &c.

Leaving alone the highly contentious subject of which is the more economical and efficient illuminant—gas or electricity—there is no doubt that, with the inverted gas mantle of the high Welsbach quality, giving such pure white light, and with the high-pressure Pharos gas lamps, giving such bright and well-diffused light at the highest economy (over 60 candles to the foot of coal-gas consumed), the Welsbach light has merits which must command serious attention and consideration on the part of railway lighting engineers when grappling with the interesting and difficult problem of lighting. It will interest railway lighting engineers to learn that the high-pressure lamps in the Pharos Welsbach system (and, as a matter of fact, their low-pressure lamps also) may be switched on or off in groups as may be required; the Welsbach light may thus be claimed to enjoy conveniences similar to the electric light in this respect.

In this connection it should be mentioned that the high candle-power inverted arc lamps on low-pressure gas service which the Welsbach Company are now putting on the market, allow that in a 1,000 c.-p. three-burner lamp, two lights, for example, may be turned off, while the third, a midnight flame, may be kept alight.

To revert to the Welsbach mantles, the exceptional advantages of the bijou mantle for the lighting of railway carriages are well known. These mantles are of the very highest quality, so as not only to give a brilliant light, but also to afford sufficient strength to withstand the constant vibration to which they are exposed.

There are, of course, many other kinds of upright and inverted mantles made by the Welsbach Company, and, to name a

speciality, we would mention the loom-woven types which appear to find great favour amongst certain users. For high-pressure gas the Welsbach soft inverted mantles of the single or double type enjoy a unique position as regards their light-giving capacity and strength.

Arc Lamps for Railway Yards, &c.

Messrs. Siemens Bros. (Caxton House, Westminster, S.W.) have sent us some particulars of the "CAXTON" FLAME ARC LAMP, which they have recently placed on the market. This lamp is specially suitable for the lighting of large areas, open spaces, railway yards, &c., on account of the excellent distribution of the light. The maximum candle-power is obtained at an angle of about 30 deg. from the horizontal, as compared with 70 deg. in the ordinary inclined carbon arc lamp. This modified distribution has been obtained by placing the positive carbon below the negative, which has also the advantage of causing the arc to burn more steadily. This class of lamp is also very simple in design, and as the carbons used are much larger than is usual in a flame arc lamp, the risk of breakage is considerably reduced.

"Nico-Intensified" Shop Lamp.

It will be recalled that we recently referred to the "Nico" high candle-power lamp (illustrated on page vii.), fitted with two or more burners, and suitable for outdoor lighting.

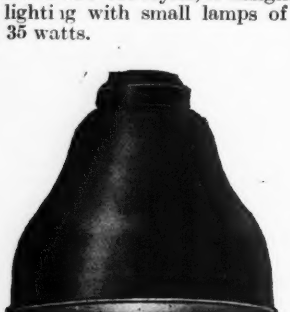
The lamp illustrated herewith has also been specially designed by the **New Inverted Incandescent Gas Lamp Co., Ltd.** (19 and 23, Farringdon Avenue, London, E.C.), with a view to providing a high candle-power single-burner lamp suitable for *indoor* lighting of all kinds, such as shops, railway waiting-rooms, factories, &c. It is of compact form, the overall length being only 26½ in., and it combines all the latest improvements developed by the manufacturers. The single burner gives, we understand, as much as 250 c.-p.

Holophane-Benjamin Steel Reflectors.

The Benjamin Electric, Ltd., 117, Victoria Street, London, S.W. inform us that they have now prepared their catalogue and price-list of Holophane-Benjamin Steel Reflectors for industrial lighting.

These reflectors have been designed to fulfil the special requirements of mills, factories, workshops, dockyards, and railway stations.

They are manufactured in five types, four of which are for pendant use with lamps of different sizes ranging from 17 to 300 watts; while the fifth type, which is parabolic in three styles, is designed for local lighting with small lamps of from 17 to 35 watts.



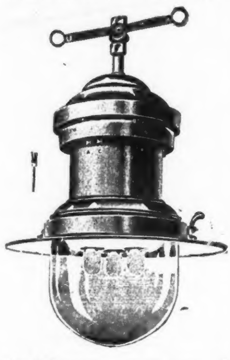
No gallery is required for these reflectors, which can be fitted to an ordinary lampholder with shade carrier. For outdoor work they can be supplied with the "Benco" weatherproof lampholder.

The accompanying illustration shows the appearance of these steel reflectors, this particular example being one of the intensive type.

We have to acknowledge the receipt from **Messrs. Simplex Conduits, Ltd.** (113–117, Charing Cross Road, London, W.C.), of a very elegant Diary for 1912, bound in leather, and containing a large amount of tabulated information in very concise form, including particulars and prices of the chief Simplex Specialities, and several pages of general tables of use to Electrical engineers.

A New Inverted Lamp for Exterior Lighting.

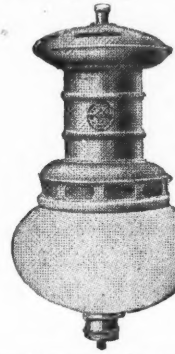
THE "UKAY" INVERTED LAMP shown in the accompanying illustration has been recently brought out by **Messrs. Falk & Stadelmann** (83–87, Farringdon Road, London, E.C.) for exterior lighting. This lamp has already been adopted by several of the leading railway companies, and we are informed that it has proved very satisfactory for the lighting of stations, goods yards, and shunting yards. A special feature of the lamp is the regulation of the gas and air, which is accomplished from the outside of the casing by means of a small key, shown on the left of the illustration. The two vertical shafts turned by this key for regulating the air and gas can also be seen in the illustration at A and G. When the mixture has once been set to suit local conditions and quality of gas, the regulators cannot afterwards be tampered with. Messrs. Falk & Stadelmann mention that the lamp is specially suitable for platform lighting when used with their patent "Noturn" ball joint, which prevents axial rotation while still retaining the usual free movement of the ordinary ball joint.



We have received from the same firm a new and very comprehensive catalogue of ELECTRICAL FIXTURES, which includes a large variety of pendant and portable fittings, and some special reflecting lamps suitable for lighting desks, pictures, reading-tables, &c. The catalogue is got up in excellent style and well illustrated throughout. Messrs. Falk & Stadelmann have also sent us a price list of "EFESCA" LAMPS, including the ordinary standard type, candle lamps, and high candle-power, round-bulb lamps.

A New High Candle-Power Low Pressure Gas Lamp.

Messrs. Moffat's, Ltd. (13, Farringdon Road, London, E.C.), have sent us some particulars of the KITLEY-NATIONAL AUTOMATIC INVERTED GAS ARC. Among the features of special interest in this neatly-constructed lamp may be mentioned the automatic regulator, which controls the gas supply under varying pressure, so as always to deliver the right amount of gas and air, and ensure uniform combustion. There is also an automatic air shutter, which has been designed to prevent explosive mixtures when lighting or extinguishing the lamp, thus saving the mantles from damage. These lamps are supplied both for indoor and outdoor use.



Kitley-National Automatic Gas Arc (Indoor Type).

With this new low-pressure lamp 550 c.-p. can be obtained for a consumption of only 15 cubic feet of gas per hour, and it is therefore specially suited for illuminating large open spaces, railway yards, &c.

Messrs. Siemens Bros. Dynamo Works, Ltd. (Tyssen Street, Dalston, London, N.E.), inform us that they are supplying the whole of the STREET LIGHTING MATERIAL, comprising standards, cast-iron brackets, lanterns, and "One-watt" lamps for the new street lighting scheme which is now being carried out at Dundalk. When completed, this town will possess a most efficient and up-to-date street lighting installation. The firm has also obtained the contract for ship lighting from the Royal Mail Steam Packet Co. for a period of six months commencing January 1st, 1912.

Owing to the interest evinced by the trade in the "Little Bill" showcard, Messrs. Siemens Bros. have decided to issue to the trade this popular design in the form of a post card suitable for correspondence. Quantities will be over-printed free of charge, and it is anticipated that the trade will appreciate these efforts to bring business their way.

Messrs. Siemens Bros. inform us that in future all tantalum lamps supplied from their works and stores will be marked with the word "tantalum" on the bulb.

Onewatt Lamps in the Tube Station.

The lighting of the Oxford Circus Station of the Central London Railway, which is shown in the accompanying illustration, is a good example of the very uniform illumination which can be produced by the use of high candle-power tungsten lamps. The installation consists of 100 candle-power "Onewatt" lamps fitted with suitable Holophane reflectors. A uniform illumination of $1\frac{1}{2}$ foot-candles at a height of 4 ft. above the platform throughout its entire length is said to be obtained at this station. The illustration is reproduced from a photograph which has not been retouched, and may be seen in the offices of the contractors, **Messrs. Siemens Bros. Dynamo Works, Ltd.** (Tyssen Street, Dalston, London, N.E.).

We have received from **Messrs. The British Thomson-Houston Co., Ltd.** (83, Cannon Street, London, E.C.), a note, in which they draw attention to the 'READY RULES FOR LIGHTING WORK' recently issued by them. They point out the valuable work of the Illuminating Engineering Society in collecting technical information on the subject of lighting. They are now putting the results of the deliberations of this Society into practice in the scheme of complete lighting units now being developed by the Company.

The British Thomson-Houston Company also desire us to announce that they have organized an Illuminating Engineering Department to freely give expert assistance to architects, engineers, and contractors in the planning of illumination along the most approved and efficient lines. This department is capable of undertaking all kinds of illuminating engineering work from the home to the office, and from the shop to the largest interiors, depots, railway stations, assembly halls, auditoriums, &c. The Illuminating Engineering Department of this Company have offices and engineers at Rugby, London, Manchester, and Sheffield.

We have also received from the same firm a pamphlet dealing with the 'Care of the Eyes.' The development in late years of high candle-power tungsten lamps and other light sources of high intrinsic brilliancy has made it imperative to protect the eyes from the light of bare lamps. The British Thomson-Houston Co. insist upon the necessity of using a shade of some sort, and suggest that it is more economical to equip a lamp with scientific prism glass, such as the "Mazdalier" reflectors than with a light absorbing shade of the ordinary kind.

The Electrical and Engineering Supplies Co., Ltd. (36 and 37, Upper Thames Street, London, E.C.), have sent us a copy of a new leaflet dealing with MOTOR-DRIVEN AUTOMATIC SIGN SWITCHES. A particular feature of these switches is the standardization and interchangeability of parts, which makes it possible to give quick delivery of any size, and to supply any spare parts subsequently required from stock.

We have received from **The Wardle Engineering Company** (196, Deansgate, Manchester) a very comprehensive catalogue of LANTERNS AND FITTINGS for street and indoor lighting. These lamps have been designed for use with metal filament incandescent lamps, and are made to take one or more lamps, according to the purpose for which they are intended, ranging from one 50 c.-p. lamp up to a cluster of 2,000 c.-p.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

Few contributions of very striking novelty have appeared this month. The American *Illuminating Engineer* again contains a series of fully illustrated articles. That on **Railway Illumination** in *The Electrical World* (Dec. 2nd), which contains some data on the illumination necessary on platforms, booking halls, offices, &c., is of interest at this moment, and a discussion of the United States Illuminating Engineering Society on **Theatre Lighting** is also briefly reported. An interesting summary of a discussion at the Hygiene Exhibition, terminating in a series of general sanitary recommendations on lighting, appears in the *Elektrotechnische Zeitschrift* (Nov. 30th).

An account is also given of the lighting of the new New York Library. It is interesting to observe that in the reading room a combination of general and local lighting is employed.

Among articles of a more strictly scientific nature we may note the continuation of HOUSTON's serial article on **Radiation** (*Electrician*, Dec. 1st, 15th), now dealing with mercury lamps; while P. G. NUTTING (*Elec. World Rev.*, N.Y., Nov. 25th) gives the results of some further researches on the **Helium Standard of Light,** previously described by him, and now found to be reproducable with extreme accuracy. LUCKIESH amplifies his previous researches on coloured light and Visual Acuity, and finds that the best results in this respect are to be secured with monochromatic yellow light. BLACIZEK (*Elek. u. Masch.*, Dec. 10th) contributes a mathematical discussion of the calculation of horizontal illumination from a source at a prescribed height, and *The Gas World* (Dec. 2nd) reproduces a paper by PROF. H. STRACHE on the **Calculation of Mean Spherical Candle-Power.** F. REITZENSTEIN (*Z. f. B.*, Dec. 10) contributes a readable summary of recent suggestions regarding **Standards of Light.**

ELECTRIC LIGHTING.

L. BLOCH (*Elek. u. Masch.*, Dec. 3rd) contributes a readable analysis of the functions of **Reflectors** for use with tungsten lamps in street lighting, illustrating and giving the results of tests on three forms, respectively conical, parabolic, and convex-spherical in shape. CADY (*Elec. Rev.*, N.Y., Nov. 25th) summarises very fully the results of a number of authorities on the constants connecting pressure, watts, and candle-power of glow lamps, and deduces rules connecting these quantities. CHENEVEAU contributes a general summary of **Recent Articles on Incandescent Glow Lamps.**

The Electrician (Dec. 8th) has an interesting short article suggesting the use of condensers in series with metallic filament lamps on alternating current circuits as a means of reducing the voltage. A point to be noted is the necessity of avoiding a sudden rush of current when the lamp is switched on.

GAS, OIL, ACETYLENE LIGHTING.

There are several Continental articles. BENKE (*Z. f. B.*) discusses the recent suggestions of Coste and Powney for testing mantles, arguing that something simpler than the existing prescribed methods is required.

The *Journal f. Gasbeleuchtung* contains some interesting contributions from ladies (Frau M. von Nettelbladt, Dec. 16th; Fräulein Josepha Wirth, Dec. 9th) engaged in the popularization of gas for heating and lighting. Some photographs are given of exhibits of gas companies, and suggestions made as to the best way of presenting data before the lady of the house. BÖHM (*J. f. G.*, Dec. 9th, 16th) analyzes the patent situation as regards the artificial silk mantle.

Perhaps the most interesting item in the British Press is the prolonged controversy which has been raging, under the heading, 'Some Aspects of Lighting,' between *The Journal of Gaslighting* and a correspondent of *The Daily Telegraph.* Whatever the conclusions to be drawn, the argument makes most interesting reading, and will be valuable for future reference on the highly debatable points discussed. In this connexion the comparison of the costs of lighting by electric flame arcs and high pressure by W. BERTELSMANN (*J. G. L.*, Nov. 28), is also of interest.

Another point dealt with by the *Gas World* is the steaming of the insides of show-windows in shops lighted by gas. This defect, it is suggested, can be avoided by proper attention to the ventilation, or by excluding the lamps from the window itself by means of a glass screen underneath them.

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GAS, OIL, AND ACETYLENE LIGHTING.

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Wirth, J. Ueber Gasverwertung (*J. f. G.*, Dec. 9).
The Lighting of Court House Square (*Am. Gas Light Jour.*, Nov. 27).
The Theory of the Incandescent Mantle (*Prog. Age*, Dec. 1).
Gas-lighted Shops and Steaming Windows (*G. W.*, Dec. 9).
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Comparative Costs of High Pressure Gas and Flame Arc Lamps (*J. G. L.*, Nov. 28).
L'Emploi de l'Acétylène dans les Services Sanitaires des Avant Postes (*Rev. des Eclairages*, Nov. 30).
L'Eclairage des Petites Villas (*Rev. des Eclairages*, Dec. 15).
Ueber Luftgas und einen neueren Aparat zu seiner Erzeugung (*Z. f. B.*, Dec. 10).

CONTRACTIONS USED.

Elek. u. Masch.—*Elektrotechnik und Maschinenbau.*
E. T. Z.—*Elektrotechnische Zeitschrift.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. f. G.—*Journal für Gasbeleuchtung.*
J. G. L.—*Journal of Gaslighting.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

Some Publications Received.

Proceedings of the Faraday Society.—These include a paper by W. R. Cooper giving further particulars of the "Benkö" primary battery, to which reference has previously been made in this journal.*

City of Birmingham Gas Department Magazine.—A new monthly magazine devoted primarily to matters of interest to the employees of the gas department.

Sectional Guide to the Library of the Patent Office.—The section we have received is a subject list of the works on Peat, Destructive Distillation, Artificial Lighting, Mineral Oils and Waxes, Gas Lighting, and Acetylene. We notice among the authors on Artificial Lighting, such Continental authorities as Lummer and Wedding, while among the American contributors may be mentioned Dr. L. Bell, J. R. Cravath, V. R. Lansingh, C. P. Steinmetz, and others. The list of books dealing with Photometry is very comprehensive, and the recent dates of the works on Acetylene afford some indication of the rapid growth of this industry.

The Physical Review.—This number contains a further contribution on 'Luminescence' by Messrs. Nichols and Merritt, and a note by F. C. Brown on the 'Selenium Cell and the Nature of Light Action in Selenium.'

We have also to acknowledge the receipt of the following:—*Journal of the Royal Society of Arts, Journal of the Society of Architects, Proceedings of the American Institute of Electrical Engineers, American Chemical Journal, Journal of the Western Society of Engineers, Bulletin of the Bureau of Standards, Proceedings of the American Academy of Arts and Sciences, Zeitschrift für wissenechaftliche Photographie, Photophysik und Photochemie, Atti della Associazione Elettrotecnica Italiana.*

* *Illum. Eng.*, vol. iv., Aug., 1911, p. 453.

REVIEWS OF BOOKS.

L'ÉCLAIRAGE A L'INCANDESCENCE PAR LE GAZ.

By Paul Lévy.

H. Dunod et E. Pinat, 47–49, *Quai des Grands Augustins, Paris*, 1910.

This book differs from many others on gas in being confined solely to lighting matters.

The author commences by giving a brief review of the history of gas lighting, and traces the development of burners from the flat flame to the incandescent type. An account is given of the processes of manufacture of mantles, and this is followed by a useful summary of the discussion (by Bunte, Vivian Lewes, Fèry, and others) that has raged round the theory of the subject. Following this, improvements in burners, as illustrated by the Kern, Bandept, and other types, are discussed, and a few words are said on the inverted variety.

Subsequently the design of lanterns is dealt with, and a specially minute account is given of various types of torches for lighting up, electric and pressure methods of distance ignition, &c. At this point the author breaks off to review the more recent history of incandescent lighting in France and abroad, the particulars for France being particularly full. This section of the book concludes with a discussion of some practical problems, including the lighting of streets and towns, railway carriages, luminous signs, lighthouses, &c.

Up to this point we have been dealing with the edition of this work up to the year 1905, which concludes with an index in the usual way. The author, however, sets an admirable example by adding a supplement in which the same ground is briefly covered again from the standpoint of the improvements of the last five years. In this section high-pressure gas lighting comes in for special notice, and further interesting particulars are given of automatic ignition, including the magneto-electric methods being experimented with on the French railways.

This book, containing as it does an up-to-date summary of recent progress in gas lighting, will doubtless interest many readers of this journal, and the account it gives of the developments in France during the last few years should appeal to many gas engineers in this country.

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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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EDITORIAL.

Colour Discrimination by Artificial Light.

THE interesting paper read by Mr. Ritchie on the above-named subject before the last meeting of the Illuminating Engineering Society was a most stimulating one. This subject of colour discrimination by artificial light is of exceptional interest to many trades—carpet manufacturers, colour-merchants and lithographers, florists, drapers, &c. While it is recognized that we have as yet only touched the fringe of the subject, there can be no doubt that this meeting will lead to many supplementary and corroborative researches being carried out.

One of the most striking points in this paper was the ingenious manner in which the author combined photographic tests, measurements of reflecting power, and analysis of colour with the Tintometer to support his contentions. The conclusion arrived at by the lecturer regarding the qualities of the arc light is most important. We may point out, however, that the list of illuminants so far dealt with is incomplete. As the Chairman (Mr. Goodenough) mentioned, the qualities of high pressure gas lights may be expected to differ to some extent from those of low power ordinary pressure burners, and might be found to approach daylight more closely. We should also like to see some data given for acetylene, petrol air gas, and the Moore carbon dioxide tube, for which excellent colour-matching qualities have been claimed.

It may also be pointed out that there are still a number of practical problems arising out of the discussion of this paper which would well repay study. The requirements of an ordinary draper or florist, for example, may not be so severe as those in certain textile and dyeing works, in which the discrimination of fine shades of colour is made a fine art. In the former case, an illuminant which came reasonably close

to daylight (or a form of screen which converted the light from incandescent lamps or incandescent gas into a fairly close approximation thereto) might be found to answer. But when the precise standardization of exact shades of colour is in question much greater accuracy may be demanded. Any artificial light used must not only resemble daylight as perfectly as possible, but must also be reproducable with extreme exactitude. Now some difference of opinion seems to exist as to the extent of the colour-variations of normal daylight. How closely, one would like to know, can one specify "white light," and with what accuracy may we theoretically expect to reproduce it?

Then, again, it must be borne in mind that while some delicate shades of colour are very susceptible to slight changes in the spectrum of an illuminant, there are other commoner colours which vary much less, and which might possibly be selected and matched with tolerable certainty even by artificial lights which depart to some extent from daylight. It would therefore be of great value to drapers and others if a chart of colours could be prepared, enabling them to see which shades were materially altered, and which were comparatively slightly affected. The draper would then at least know which colours it was no use trying to match. Charts of this kind might be prepared from standard dyed materials, and might be adapted to illustrate the differences in tint caused by all the chief illuminants. But the appearance of the chart would naturally depend upon the illuminant by whose light it was inspected, and it might therefore be necessary to prepare a series of charts for use with different artificial lights. The result would be most valuable, but it would, of course, require much careful and patient work.

The Production of Artificial Daylight.

Arising out of Mr. Ritchie's paper there is a second most fascinating problem, the artificial production of daylight, *i.e.*, the conversion of the spectrum of some artificial illuminant into that of normal "white" light. It will be recalled that a short time ago the work of Drs. Ives and Luckiesch in this direction was described in this journal.* His method consisted in preparing a special screen (composed of suitably coloured glass and gelatine) which, when placed in front of a tungsten lamp, converted its light into something very near daylight. We understand from Dr. Ives that a further simplification in his screen has since been made, and that his experience with it has so far been quite favourable.

At our last meeting a special ("Wratten") screen of this kind was exhibited by Dr. Kenneth Mees, and it will be most interesting to follow the future of this lamp. As shown by Dr. Mees the lamp assumes a very convenient and portable form, and is expected to prove very valuable to those concerned with colour work. Mr. Trotter also described some valuable researches on the use of glasses for the same purpose. The interesting point about such screens is that if it is possible to do this for an electric tungsten lamp, it might no doubt in time be also possible to do the same for incandescent gas or any other illuminant. It might even be within the bounds of possibility to provide a series of screens by which the light from, say, a tungsten lamp might be made to resemble exactly that of incandescent gas, or daylight, or arc lamps, or any other illuminant. If this could conveniently be done the draper, for example, by using a series of booths with appropriate screens, would be able to show customers successively how a given colour would appear under any particular illuminant.

Whatever be the outcome of this discussion, however, we may feel sure it represents an important step forward. It has kindled public interest in the

* Vol. IV. 1911, p. 394.

subject and paved the way for a more scientific treatment of colour problems in the future.

The Hygienic Aspects of Illumination.

The article by Dr. Moeller which we publish on page 57 must be most gratifying to all connected with the illuminating engineering movement. Dr. Moeller, as President of Second Congrès International des Maladies Professionelles, is naturally able to speak with special authority on the hygienic aspects of lighting and it is most satisfactory for the claims of good illumination to receive such distinguished support. It will be recalled that at this Congress special reference was made to the importance not only of providing enough light but also of distributing it in a rational and satisfactory way and to the need for adequate lighting of dangerous machinery. This matter is again mentioned by Dr. Moeller.

The step taken by the French Government in appointing a committee to study the Hygienic Aspects of Illumination is described as a most important step which, it is hoped, will shortly also be taken by the Belgian Government and in other European countries. We sincerely hope that this will be done. The problems in question are of a particularly complex type and it is well known how important is corroborative evidence on all physiological matters. It is necessary in the first place to avoid being misled by the inevitably somewhat different impression received by various individuals; experiments must therefore be made by a number of observers on different people. Again it is quite possible that the circumstances to be met in a particular branch of industry may not be the same in all countries. Also it is at present almost inevitable that the methods of research adopted by the experts in charge of an investigation in various countries should differ to some extent.

For all these reasons we hold that it is very essential that such researches should be repeated in various countries and the results subsequently compared with each other in order to derive some generally acceptable conclusions. For this purpose we should like to see committees on lighting similar to that announced in France constituted in all the chief European countries. These committees should agree upon a common line of research and keep in constant touch with each other and they might eventually meet together with a view to combining the points on which there is general agreement in one common report.

We have heard it said that there is no need to form a Government Committee on Illumination in this country because this work has already been undertaken in France. But we think we have already said enough to show that the experience of a limited number of experts in one country by no means constitutes an infallible guide to another. And apart from this one would naturally like to see Great Britain, which has been hitherto well to the front in studying industrial hygiene, also taking the lead in connection with illumination, and not waiting to see what others will do. The Factory Department of the Home Office has already shown its sympathy and a beginning has been made. But a little extra encouragement and forethought at the present moment would lead to the accumulation of most valuable data during the next few years and a thoroughly representative and influential committee would undoubtedly be able to make useful suggestions as to how the existing machinery could best be utilized for this purpose. Our Society could no doubt help considerably in the accumulation of data and useful information if once this Committee was formed to undertake the supervision of the work.

A Coming Congress on the Prevention of Industrial Accidents.

The announcement of the coming Congress on the Prevention of In-

dustrial Accidents, which we publish on p. 59 appears at an opportune moment, following as it does the important article by Dr. Moeller.

For among the many evil results of poor lighting one of the most obvious and striking is its direct influence on the number of accidents in factories. The lighting of dangerous machinery formed one of the main points selected for mention in the summary of the proceedings at the Congress in Brussels. It was pointed out then that an improperly placed light, which dazzles the eyes of workers instead of illuminating the object to be seen, is worse than useless; it may actually lead to accidents. In the same way the report of the recent Departmental Committee of Accidents in Factories and Workshops contained much striking evidence to the same effect, instances being quoted of men losing their footing or stumbling under dangerous circumstances (as, for example, when carrying ladles of hot iron), through insufficient light. It need hardly be pointed out, therefore, how serviceable it would be for inspectors of factories, representatives of insurance companies, and others, to agree upon some simple rules of good lighting with a view to avoiding these defects.

This, perhaps, may before long be supplemented by more precise recommendations as to the standard of illumination requisite in different circumstances. Meanwhile it would be most useful if a system of recording the conditions (if possible including actual tests) of illumination at the time each accident occurred could be organized By this simple means we should soon accumulate data enabling us to trace a direct connection between accidents and poor illumination, and we should soon learn by practical experience what defects in lighting to avoid particularly in certain trades.

Knowledge of this kind would be appreciated by the managers of industrial concerns as well as the employees. Mishaps almost invariably involve disorganization in work as well as expense in compensation for injuries. This is emphatically a case in which prevention is better than cure. Moreover the means of prevention, as far as illumination is concerned, are comparatively simple, for in most instances attention to one or two fundamental rules of good lighting would have immediate beneficial results, and would carry with it the additional advantage of improved quality of output and a reduction in the percentage of spoiled work. We have often pointed out that the improvement thus secured would fully justify the comparatively small extra expense involved in putting the lighting on a sound basis. The truth of this is rapidly becoming recognized amongst manufacturers to-day.

In conclusion we need only draw the attention of our readers to the important nature of this Congress. Sig. F. Massarelli, the General Secretary, has himself taken a keen interest in illumination and was one of those who read a paper on this subject at the Congress in Brussels. We hope that many influential delegates from this country will be present. The writer has undertaken to act as delegate of the Illuminating Engineering Society and read a paper on the Relation of Bad Lighting and Accidents, and he would be much indebted to any members of the Society who could kindly supply him with data summarizing their personal experiences in this matter so as to enable as complete a report as possible to be presented of cases in which bad lighting has been a cause of accident. Such data would help very materially to improve the present unsatisfactory condition of affairs.

LEON GASTER.

Review of Contents of this Issue.

THE TECHNICAL SECTION (p. 57) contains an article by DR. A. MOELLER, in which he discusses **Illumination from the Hygienic Point of View**. He points out that the general importance of the subject is now becoming more fully recognized, and then refers to the papers dealing with factory lighting which were presented at the Congrès International des Maladies Professionelles held in Brussels during September, 1910 (and of which Dr. Moeller was President). He also emphasizes the feeling that was expressed at that congress, viz., the importance of satisfactory lighting of dangerous machinery, &c., in factories, and points out that it is not only a sufficiency of light which is important, but the placing of the lights in the best possible position. The resolution passed at the recent Congress of Applied Electricity at Turin, sanctioning the appointment of an International Commission to deal with illumination is next referred to, and the action of the French Government in appointing a State Committee on the Hygiene of Lighting is mentioned as evidence of the importance attached to the question of lighting by the authorities in that country. It is hoped that this precedent will be followed by the Belgian Government also.

On p. 59 is a preliminary announcement of a Congress on the Prevention of Accidents, to be held at Milan in May next. The importance of illumination in connexion with the subject of the Congress will doubtless be fully recognized.

On p. 63 will be found a report of the meeting of the Illuminating Engineering Society on January 16th, when MR. T. E. RITCHIE read a paper on **Colour Discrimination by Artificial Light.**

After outlining some of the considerations which led him to undertake his research on colour discrimination, Mr. Ritchie gives a very full account of his method of photographing a set of coloured ribbons lighted by a number of different illuminants, and afterwards developing and printing the photographs under identical conditions so that the tone values could be accurately compared. In addition to this photographic estimate of the effect of the different illuminants on the colours, the author also includes a tabulated summary of the visual effects observed, and suggests that by taking both into consideration, a useful judgment can be formed.

The discussion which followed is reported on pp. 75-85. MR. M. LOUDAN mentions some experiments in matching colours by artificial light which were carried out at the Westminster Art School. MR. S. E. THORNTON expresses his interest in the lighting of pictures, and points out that delicate blue tints are particularly difficult to show by artificial light. MR. V. H. MACKINNEY refers to the use of coloured photographs of interiors, and to the method of examining the effect on colour of different illuminants placed in boxes side by side, so as to light a set of ribbons. DR. KENNETH MEES describes how he calculated a curve (reproduced at the meeting), which would show the effect on a photographic plate of the colours right through the spectrum, as compared with their effect on the eye. He also points out that the difficulty with green colours met with in Mr. Ritchie's photographs might be due to the fact that they were somewhat dark, and therefore under-exposed, thus coming into a region where the plate used could not give a correct tone value:

MR. A. P. TROTTER deals with the method of describing the colours adopted by Mr. Ritchie, and then passes on to deal with his own experiments on the production of artificial daylight. He refers also to the work of Ives and Luckiesh, and the difficulty of the impermanence of the dyes used

in colour filters. Mr. Lovibond emphasizes the importance of regarding the colour measurements from the physiological standpoint, and also draws attention to the important effect which the angle of the incident ray has upon the intensity of light for a particular colour. Dr. F. W. Edridge-Green points out how much the character of a colour varies according to its intensity, as can be seen by using a double-image prism, and thus varying the intensity of the colours side by side. Mr. J. Eck mentions how a picture (shown at the meeting) was painted half by daylight and half by the light from an inverted arc lamp, in order to demonstrate how completely similar the colours appeared by either light. Mr. Harrison doubts whether artificial daylight would be much used even if it could be readily produced, as dress materials, &c., are usually chosen by the light under which they will be subsequently used.

Dr. Kenneth Mees also describes a filter which he has produced, giving an extremely accurate reproduction of daylight when used in conjunction with a tungsten lamp, and he points out that the dye used in this filter is quite permanent. He suggests that the only satisfactory method of comparing artificial with natural daylight is to make a complete spectro-photometric analysis.

Among the communicated remarks Mr. J. S. Dow alludes to some difficulties in testing coloured ribbons, and mentions some experiments with a view to constructing a portable instrument for this purpose, while Mr. J. Darch deals especially with the yellow light and its effect in changing pale yellow almost to white.

Mr. Ritchie, in his reply, emphasizes the fact that no filter of any kind was used with the arc lamp tested in the course of his colour experiments. He defends his method of describing the colours on the ground of simplicity and popular understanding, and considers the "tintometer" analysis as a useful record, enabling the colour to be easily reproduced. He replies in detail to the other points raised in the discussion.

The section of the journal devoted to the transactions of the Illuminating Engineering Society also contains an account of the **Discussion** on Mr. Harrison's paper on **Railway Station Lighting,** which is concluded in this number (pp. 87–100). Mr. Roger T. Smith and Mr. Frank Bailey both refer to the figure of 0·25 foot-candle for minimum illumination on platforms, the former thinking it extravagant for certain types of station, the latter advocating it for all stations. Mr. H. Burgess gives some results that he had obtained for high-pressure gas lighting on one of the Midland Railway stations. Mr. Herbert Jones suggests local illumination for ticket barriers, and classifies the lighting of stations, according to whether they are roofed or not, while Mr. Trotter thinks that a system of "mixed" lighting, as advocated by Mr. Bailey, would mean reduced efficiency. Mr. Grove and Mr. Severs give their experiences in the lighting of the Central London and Great Northern and City Railways respectively. Mr. J. G. Clark refers to a case in which inverted mantles effected a saving of nearly 50 per cent, as compared with upright mantles, although the illumination was practically the same in each case. Among the communicated remarks, Mr. C. R. Williams describes the illuminating practice on the Great Western Railway, and Mr. J. Y. Fletcher refers to the possibility of using a double-filament lamp for economizing in stations where a bright light is only required when a train is in. Mr. Eck questions some of the figures given for flame arc lighting, and emphasizes the fact that station lighting must never be allowed to interfere with the observation of signals. Mr. T. E. Ritchie asks a number of questions with regard to the figures for tungsten and arc lighting given by Mr. Harrison. The discussion concludes with a full reply by Mr. Harrison to the various points raised by speakers.

At the end of the magazine will be found the usual **Trade Notes** and **Review of the Technical Press.**

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

Illumination from the Hygienic Standpoint.*

By Dr. A. Moeller (President of the Second Congrès International des Maladies Professionelles, President of the Academie Royale de Médecine, Member of the Commission des Accidents du Travail, Hon. Member of the Illuminating Engineering Society).

During the last few years the various systems of electric lighting have made most remarkable progress. Formerly the choice of illuminants was very limited. Now the varieties of lamps have multiplied exceedingly; and, more, the methods of distributing and using artificial light have been improved with equal rapidity.

This progress has not been the privilege of any single nation; in Europe, as in the United States, the technicalities of lighting have undergone considerable modifications. Illumination, one may say, has become an international question. People are now not only preoccupied with the question of the amount of light given by various lamps for a given consumption of gas and electricity; but also in studying the problems of illuminating schools, shops, factories, streets, and public places in a better manner.

It would therefore be very beneficial if uniform methods of comparing the different systems of lighting could be fixed and adopted in various countries. It would be useful in doing so to establish an agreement as regards cost of lighting, intensity, colour, and distribution of light. There are still other interesting problems which await full solution, such as the development of better methods of measuring light and also of determining the degree of illumination requisite for various industrial uses. In addition—and this is a matter of special importance—it is very necessary to enter upon a special study of the influence of illumination upon the eyes, on health generally, and of its relation to the number and frequency of industrial accidents.

Such questions led to the origination of the Illuminating Engineering Society in the United States in 1906, which has already 1,500 members. Subsequently, in 1909, a society with similar aims was started in London, which has already accomplished remarkable work. Its proceedings are published in a special journal (*The Illuminating Engineer* of London).

It may be mentioned that this Society was represented at the last Congrès International des Maladies Professionelles by its Hon. Secretary (Mr. Leon Gaster), who presented a paper on 'The Hygienic Aspects of Lighting'; contributions on the same subject were presented by Dr. Broca, M. Massarelli, Dr. Terrien, &c. The discussion revealed the special necessity of providing sufficient illumination in the neighbourhood of possibly dangerous machines, and it was recognized that defective illumination was a frequent cause of more or less serious accidents.

A most important event in this connection has been the nomination by

* The article kindly sent us by Dr. Moeller also appeared in the *Mouvement Hygiénique* and is reproduced in the *XXe Siècle* (Jan. 6th, 1912).

the French Government of a Commission composed of medical men (oculists and others), gas and electrical engineers, inspectors of factories, &c., which will make a special study of different methods of lighting and their suitability for special purposes. This Commission will also study methods of measuring illumination and the effect of insufficient illumination from the hygienic standpoint.

Finally, in September, 1911, an International Electrical Congress was held in Turin, one section of which had for its object the study of lighting. Mr. Gaster on this occasion presented a resolution which was carried unanimously, to the following effect :—

"That this Congress deems it desirable that an International Commission should be appointed in order to study all systems of lighting and technical problems in connection therewith ; and, having been informed that the Illuminating Engineering Society of London has the intention of forming such a Commission, and of putting itself in touch with the other existing national and international photometric committees, approves their taking the initiative in this respect."

Following this, Mr. Gaster visited some of the chief countries in Europe in order to suggest the formation of local committees to study this question of illumination, the members of which should constitute an international commission. He also honoured me with a visit, suggesting that I should use my influence towards the formation of an official commission by the Belgian Government similar to that formed in France. It is in response to this suggestion that I have written this short note.

It is, I think, needless to enter into long arguments to prove the vital interest from the hygienic standpoint of this matter of satisfactory illumination.

It is obvious that, with a view of preventing industrial accidents, it is very important to take measures to secure a sufficient and reasonable illumination of workshops. Experience and common sense alike suggest that many industrial accidents are due to the lighting conditions not corresponding with the requirements of the work. It may be pointed out that it is not only necessary to see that the quantity of light provided is sufficient, but also to ensure that it shall be distributed in a rational and methodical way.

Illumination is especially important from the point of view of the vision of workers. This again calls for control of the amount of light. But in addition we must ascertain the effect on the eye of its qualities as regards brilliancy or softness, steadiness or variability, whiteness or colour. There are a host of such problems requiring investigation, some more difficult than others.

Next, in the interests of the general health of workers, lighting must be studied in all its aspects. From this standpoint the question of the quantity of light may not appear so important. But there are other matters which arise and likewise require the attention of hygienic experts. For example, there is the question of the vitiation of the air by various systems of artificial lighting, the influence of certain products of combustion, the heating effect on the air, &c. Then, again, there is the question, very little studied as yet, of the influence of the colour of the light. We know that luminous rays exercise a differing effect on the human organism, according to their colour. This influence of coloured light has already been utilized for phototherapeutic treatment. Who can say, therefore, that it may not exercise an appreciable influence in general lighting ? Here, again, is a vast field awaiting exploration.

In what has been said above we have only dealt with illumination from the industrial side. In reality this subject is much wider than this, and demands study on other quite different grounds. As an instance, I may mention the lighting of schools. Great progress in this respect has already been made, but mainly in connection with daylight illumination. Insufficient attention has, perhaps, been paid to the conditions of artificial lighting prevailing in certain night schools. Then, again, one may mention the lighting of shops. Here

the conditions of illumination are arranged with a view to strongly illuminating the goods and attracting the attention of passers-by, but it does not receive much attention from the standpoint of the health of employees. I need only make passing mention, as other examples of important lighting problems, of the illumination of churches, theatres, streets, public places, railway carriages, &c.

These considerations surely suffice to demonstrate the scope of the problem facing the sanitary expert. At first sight the problem appears simple, but on closer examination one is struck by the many highly important aspects of the question which have been hitherto quite disregarded.

It will readily be understood that in order to elucidate these problems it is necessary to make a preliminary study of all that concerns the technicalities of light-production. If one desires that the researches carried on in different countries should be fruitful, it is necessary to agree upon the methods of measuring light, and on the terminology and the significance to be attached to the various figures and quantities employed. These considerations show the need of establishing an international understanding, so that the researches should be conducted on a common principle and with similar aims. We do not doubt but that the Belgian government will bear in mind the example of a neighbour, with a view to uniting an international commission enabling all these experts to contribute towards the study of this new subject.

International Congress on the Prevention of Accidents in Workshops and Industrial Hygiene.

(*To take place in Milan, May* 27–31.)

THE first Congress of this kind was held in Paris in 1889, the prevention of industrial accidents being one of the subjects which received special attention. Modern experience fully bears out the popular saying "prevention is better than cure." This question of the avoidance of accidents is playing an increasingly important rôle in modern industrial countries, affecting, as it does, managers of works and engineers in all branches of work.

The initiative in arranging for a Congress to deal with this subject, and to be held in Milan from May 27th to 31st of the present year, has therefore been taken by representatives of the chief associations concerned with the prevention of accidents (3 in France, 1 in Belgium, and 1 in Italy), and an influential international committee has been formed. It may be anticipated that the importance of good illumination and its effect on the avoidance of accidents in factories will receive special attention.

The President of the Congress is to be M. le Chev. L. Pontiggia, Director of the Association des Industriels d'Italie pour prévenir les Accidents du Travail, and the General Secretary is Sig. F. Massarelli, Chief Inspector of the same association. A distinguished Committee of Honour has been nominated, the Presidents of which are Prof. F. Nitti, the Italian Minister of Agriculture, Industry, and Commerce, and Prof. L. Luzzatti, Minister of State, and the Congress is to take place under the patronage of H.M. the King of Italy.

This Congress will doubtless be of interest to many in this country concerned with industrial illumination. All particulars can be obtained from the General Secretary, SIG. FRANCESCO MASSARELLI, 61, FORO BONAPARTE, MILAN, or from Mr. L. Gaster, 32, Victoria Street, S.W.

Good Lighting now Required in Factories.

An interesting instance of the growing appreciation of the need for good illumination in factories was provided by a question in the House of Commons, reported in *The Daily Telegraph* for December 16th, 1911.

Mr. Lansbury asked whether the right hon. gentleman (Mr. McKenna) would make inquiries regarding the yard at Birkenhead of Messrs. Cammell, Laird & Co., with a view to ascertaining how many of the accidents were due to bad lighting, and whether he could arrange for the inspector to visit the yard at night.

In reply Mr. McKenna intimated that the suggestion was very reasonable, and that he would arrange for steps to be taken in this direction.

This incident is referred to in an interview with Mr. L. Gaster in *The Morning Post* (January 23rd, 1912) in which reference is also made to the suggestions of Dr. Moeller for the promotion of committees to deal with the 'Hygienic Aspects of Illumination by the Governments of Various Countries.' The hope is expressed that Great Britain will follow the useful precedent set by France in this respect.

Lectures on Illuminating Engineering.

During the past month three courses of lectures dealing with Illumination have been taking place respectively at University College, Regent Street Polytechnic, and the Northampton Institute.

The Theory of Light-Vibrations.

The course for advanced students at University College, by Prof. W. C. Clinton, commenced on Wednesday, Jan. 10th, when the lecturer dealt with 'Light, Energy and Vibration.' A series of slides illustrating the distinction between transverse and longitudinal vibrations were shown, and the nature of light waves, the phenomena of polarization, and other matters were also explained by the aid of simple and ingenious methods. One interesting feature was a succession of instantaneous photographs showing the gradual formation of a ripple in a pond when a stone is dropped in; the disturbance being compared with that giving rise to a light wave in the ether.

Subsequently Prof. Clinton passed on, in his second lecture, to various ætherial vibrations, explaining the distinction between electromagnetic Hertzian waves, visible light, and infra-red and actinic radiation. Methods of generating light were then touched upon, and it was shown how, by gaseous luminescence, a discontinuous spectrum is formed, while from incandescence a continuous spectrum (but a relatively low luminous efficiency) usually results. The physical aspects of colour were also dealt with, the analysis of white light by the spectrometer being explained and illustrated. One striking experiment was as follows: A spectrum was formed on the screen, and the lecturer then held in front of the slit of the spectroscope a vessel containing two liquids (one floating upon the other), coloured respectively red and green. Thus, by moving the vessel up and down either the red or the green half of the spectrum could be extinguished, while by shaking the vessel so that the solutions mixed, the light was blocked entirely. Some striking experiments were also shown illustrating the distinction between ordinary coloured objects and colour excited by fluorescence.

Lecture III. was devoted to the eye. Its structure was shown by various diagrams and projections of microscope sections, and the chief theories of colour-

vision were briefly summarized. Lecture IV., on Jan. 31st, is devoted to The Production of Light.

The Measurement of Light and Illumination.

The first three lectures of the series now being given by Mr. J. S. Dow at the Regent Street Polytechnic have also taken place. In the first of these, the lecturer sketched the development of the practical measurement of light. Mr. Dow also pointed out, in a few introductory words, how the previous lectures had shown the variety of illuminants now available and the necessity for precise methods of comparison; also that photometrical tests, which measured the "capacity for creating brightness" on the part of a source, must depend upon the eye. The important bearing of the lecture by Dr. Ettles would therefore be readily understood.

Mr. Dow then passed on to a brief explanation of the fundamental "inverse square" and "cosine law" in photometry. He summarized the position as regards standards of light, alluding to the work being done by the various national laboratories and the important decision to use a common unit agreed upon by France, Great Britain, and the United States. In the course of the lecture a great many different forms of photometers, including the Ritchie Wedge, Bunsen, Joly, Wild flicker, Everett Edgcumbe flicker, and other forms, were described, special acknowledgment being also made of the courtesy of the Gas Light & Coke Co. in sending the Simmance Abady street photometer for exhibition. Various other portable photometers, kindly exhibited by Messrs. Everett Edgcumbe & Co., were also described and shown.

In the course of the lecture some remarks were made on the degree of accuracy necessary in laboratory and practical work, the determination of polar curves of light distribution, and the measurement of mean spherical candle-power in the Ulbricht globe. In conclusion, the lecturer expressed his appreciation of the kindness of the firms named above, and also of the Westminster Electric Testing Laboratories, the Central Technical College, and the Birkbeck Institute in lending photometers. He thought this display of apparatus would serve to show the industrial importance now attached to photometry.

In Lecture II. Mr. Dow passed on to the measurement of illumination. He pointed out the tendency towards simple measurements with portable instruments on the spot, and analyzed the qualities which a good illumination-photometer should possess. As examples, the Preece & Trotter, Everett Edgcumbe, Harrison, Martens, Sharp & Millar, and Holophane Lumeter instruments were described. Subsequently typical illustrations of the advantages of measurements of illumination, surface-brightness, and reflecting power were given, and the application of measurements of surface-brightness in connection with photography pointed out. Mr. Dow also said something on daylight measurements, pointing out the special difficulties met with in this connection and the value of such exact tests to architects. Special reference was made to the "relative method" originally suggested by Mr. Trotter and recently adopted by Mr. P. J. Waldram. The great value of illumination measurements as a means of making a record of actual lighting conditions must also not be overlooked. In conclusion, the lecturer referred to the courtesy of Messrs. Everett Edgcumbe & Co., Messrs. Franz, Schmidt & Haensch, and Holophane, Ltd., by whom apparatus had been exhibited.

Shades and Reflectors.

Lecture III., on Jan. 25th, was devoted to 'Shades and Reflectors.' Mr. Dow commenced by recalling the warning of Dr. Ettles against the effect of glare, quoting instances to show how the presence of a bright light in the range of vision might lead to accidents and inconvenience. He also pointed out the analogy between the retina and a photographic plate, showing two photographs by artificial light, in which the effect of glare was clearly visible. Subsequently he explained the meaning of intrinsic brilliancy, and

presented a slide illustrating the recent increased concentration of light in modern illuminants. Allusion was made to the discussion on 'Glare' of the Illuminating Engineering Society, and the rules of Prof. L. Weber for the avoidance of glare were recalled.

Mr. Dow then proceeded to show a series of slides prepared by Mr. T. E. Ritchie of the Union Electric Co., showing indirect and semi-indirect lighting by arc lamps, pointing out the advantage of this system in completely concealing the bright source and diffusing the light. Some diagrams lent by Mr. J. Darch, showing how shades should be applied for this purpose, were also explained.

The lecturer then went on to an analysis of the functions of shades, globes, and reflectors, and described the uses of a great number of different types exhibited. A cabinet set up by Messrs. Benjamin Electric showed the improvement in the downward distribution of light, as compared with a bare lamp secured by the Holophane steel reflector, and a similar demonstration arranged by Holophane, Ltd., showed in an equally striking manner the advantages of their prismatic glassware in this respect. Both forms were made in the E., I., and F types, giving three distinct distributions of light, and the lecturer pointed out the great advantage of knowing exactly the results of using a scientifically designed reflector of this kind. The Holophane picture-lighting reflector and the Huntalite porcelain tubular reflector were also shown in action illuminating various diagrams; some Spookie shades lent by Messrs. Simplex Conduits, Ltd., were also displayed by the lecturer, who demonstrated the decorative effect of the colours by transmitted light. A large selection of tasteful shades kindly exhibited by the Gas Light and Coke Co., was also shown, the lecturer laying stress on the good work being done by gas companies in providing this variety and educating consumers to the use of shades and reflectors with their burners.

A series of slides, including several designed to show the use of the dioptric globe used with the Excello flame arcs for street lighting, and a view of the covered tennis courts at Dulwich, illuminated with high-pressure lamps by the South Metropolitan Gas Company, were then thrown on the screen. The lecturer concluded by expressing his obligation to the various firms named above, who had assisted so materially by their display of apparatus. The Lecture on Feb. 1st, he mentioned, would deal with colour.

AT THE NORTHAMPTON INSTITUTE.

At the Northampton Institute the series of ten lectures previously announced in this journal has also commenced. The first, on Tuesday, Jan. 16th, by Mr. S. D. Chalmers, dealt with 'The Nature of Light and Radiation.' The lecturer discussed the theory of light production, pointing out the variation in the quality and efficiency of the light from various illuminants, and explaining the distinction between light from "black bodies" and from substances showing selective radiation.

This aspect of the subject was likewise commented upon by Mr. F. M. Denton in his first lecture on Jan. 30th, when the production of light by incandescence and luminescence respectively was described, and illustrated by examples from modern electric illuminants.

Mr. A. C. Jolley, on Jan. 23rd, covered somewhat similar ground to that in Mr. Dow's first lecture, the fundamental laws of photometry, photometric instruments, the meaning and experimental study of distribution of light, mean spherical candle-power, &c., being dealt with. The Harcourt Pentane, Hefner, and other standard lamps were shown in operation. Some special remarks on the study of radiation by bolometers, radio-micrometers, &c., were also made towards the end of the lecture, and a number of instruments of this kind were on exhibition.

[We regret that owing to the necessity for bringing the account of the proceedings of the Illuminating Engineering Society up to date in this number, it has been found necessary to hold over several interesting articles, including one by Mr. Kilburn Scott on 'Electric Lighting of Streets having Permanent Verandahs.' We hope to deal with some of these in our next number. —ED.]

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

(The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.)

Colour Discrimination by Artificial Light.

(Proceedings at a meeting of the Illuminating Engineering Society held in the House of the Royal Society of Arts (London), on Tuesday, January 16th, 1912.)

A MEETING of the Society was held on January 16th, 1912, Mr. F. W. Goodenough (Chairman of the Council) being in the chair.

The minutes of the last meeting having been taken as read, the Chairman called upon the Hon. Secretary to read again the names of applicants for membership presented at the previous meeting,* who were then formally declared members of the Society. The names of applicants for membership received since the last meeting were also read out for the first time.

The Chairman then called upon Mr. Thomas E. Ritchie to read his paper on 'Colour Discrimination by Artificial Light.' (This will be found *in extenso* on p. 64.)

The discussion on Mr. Ritchie's paper was supplemented by a discussion on the production of artificial daylight, opened by Mr. A. P. Trotter. The following gentlemen took part in these discussions: Mr. M. Loudan, Mr. S. E. Thornton, Mr. V. H. Mackinney, Dr. Kenneth Mees, Mr. Lovibond, Dr. Edridge-Green, Mr. J. Eck, Mr. Haydn T. Harrison.

Subsequently the Hon. Secretary referred to a letter which had been received from Dr. H. E. Ives, in which he regretted not being able to send a sample of his latest form of filter for producing daylight, and after Mr. Ritchie had replied to the chief points raised in the discussion, a very hearty vote of thanks to the author was proposed by the Chairman, and carried with acclamation.

The next meeting was announced to take place on February 20th, when a paper would be read on the subject of shop lighting. The Chairman also announced that the Annual Dinner had been fixed for February 15th, and expressed the hope that many of the members would be present.

At the conclusion of the meeting most of the members took the opportunity of inspecting the various lamps and other apparatus which were being demonstrated.

* See *Illum. Eng.*, Jan., 1912, p. 24.

NEW MEMBERS OF THE SOCIETY.

The names of the applicants for membership, read out at the previous meeting on December 19th, were formally announced for the second time, and these gentlemen were declared Members of the Illuminating Engineering Society.*

In addition the names of the following gentlemen have been duly submitted and approved by the Council, and were read out by the Hon. Secretary at the meeting of the Society on January 16th :—

Members.

Barber, J. W.	Consulting Electrical Engineer and Cinematograph Expert, Argyle Chambers, 106, Charing Cross Road, London, W.C.
Cook, S. O.	Engineer to Holophane, Ltd., 12, Carteret Street, Westminster, S.W.
Stickney, G. H.	Lighting Engineer to the General Electric Co., 5, Claremont Place, Montclair, N.J., U.S.A.

* *Illum. Eng.*, Lond., Jan., 1912, p. 24.

Colour Discrimination by Artificial Light.

Some Notes on the Changes in the Appearance of Coloured Objects when Viewed under Various Artificial Lights.

By Thomas E. Ritchie, A.M.I.E.E., A.M.I.Mech.E., &c.

[Paper presented at a meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts (John St., Adelphi, London), on Tuesday, Jan. 16th, at 8 P.M.]

There are few users of artificial light who have not from time to time experienced the difficulty arising from the unpleasant changes in the appearance of coloured objects when viewed by any of the majority of the artificial illuminants commonly in use. Whilst it has long been recognized that colour matching can be successfully carried out by the aid of special lamps, provided with suitable filter screens, such as, for instance, the colour matching arc lamp shown in Figs. 1 and 1A, little has been known—in many cases even by those frequently called upon to advise in such matters—as to the nature and extent of the changes in appearance brought about in objects of any given colour by any given illuminant, or as to which of the many artificial lights available would in this respect most satisfactorily comply with the particular requirements of the user.

The subject is of peculiar interest and importance, quite apart from the actual matching of colours, which is now usually carried out, at all events when required at times when daylight is not available, in a small room or compartment set apart for the purpose, and illuminated by a special colour-matching lamp provided with a filter screen of the type previously referred to, and is much more widespread in its application than might at first be supposed.

The fact that the ultimate appeal of all such articles as the beautiful present-day fabrics, carpets, wall-papers, pottery, &c., is attributable to a peculiar chain of physiological and psychological events, which, whilst fully recognized, cannot altogether be explained, has long been appreciated by those responsible for the designing of such products, who, working usually in well-appointed studios and under the best possible conditions of diffused daylight illumination, concentrate their skill and knowledge upon the production of the colour shades, contrasts, and harmonies calculated to make the strongest possible appeal to the educated judgment of the ultimate user, who, in making his purchases, is influenced not by processes of logical reasoning, nor as a general rule by the result of scientific tests, but almost entirely by opinion or fancy. He purchases what he *likes* as a result of his general mental attitude at the moment, quite as much as of his power of analysis and discrimination. Suppose, therefore, that an artist working under suitable daylight conditions has in the designing of, for instance, a carpet, linoleum, or piece of the beautiful hand-printed chintz (now so widely used), made use of particular art shades of red, yellow, green, and blue, which have been carefully and accurately reproduced by the manufacturer in the finished article, it will be obvious that if such is exhibited by an artificial light of a decidedly yellow nature (such as is produced by ordinary gas jets or carbon filament incandescent lamps) its appearance will be completely altered. The reds will appear to be lightened considerably and altered in hue, the yellows brightened and changed in tone, the greens degraded and rendered yellower, and the blues darkened considerably, the intention of the designer being by these visual changes, entirely frustrated, and the ability of the article as a whole to successfully appeal to the purchaser being correspondingly reduced.

The same thing applies with even added force to the selection by the

purchaser, possessed of an educated taste, of such general objects as dress materials, haberdashery, furnishing fabrics, wall-papers, and decorations, pottery, water-colour drawings and oil paintings, as well as such special objects as, for instance, coloured furs (especially in reddish brown shades), artificial flowers, coloured bookbindings, &c. The question of the most suitable artificial light, not only for the manufacture, but also for the general illumination of displays of such goods becomes therefore of paramount importance to their makers and vendors. It is equally important to those responsible for the lighting of exhibitions of objects of art, flower, poultry, pigeon, and cage-bird shows, &c., the participators in which naturally desire to have their exhibits presented in the manner best calculated to create exactly that effect which inspires in the beholder the subtle and elusive *liking* for the objects seen which experience has proved is of vital importance in the effecting of sales.

FIG. 1.—"Coltru" Colour-Matching Arc Lamp.

The converse is, of course, equally true. Objects designed and manufactured by an artificial light of this character being true in their appeal only when viewed by such light, and being incorrect and out of balance in their tone values when viewed by daylight.

These considerations, coupled with the difficulty of satisfactorily demonstrating such changes in appearance as are known to be brought about, without the use of a special room capable of being darkened at will and containing a series of chambers or compartments each suitably lighted by one of the different illuminants, which arrangement although excellent in other respects necessitates the attendance of the interested party at the demonstration, which cannot always be secured, and lacks the advantage of portability, have led to a further careful investigation of the subject by the author with the object of determining whether, by the adoption of the improved methods and appliances now available, such changes could not be recorded photographically with the requisite accuracy and subsequently reproduced, and the results which follow are the outcome of his work in this direction.

FIG. 1A.—"Coltru" Colour-Matching Arc Lamp, with Cover (carrying Filter Screen, removed.

Preliminary experiments of an extensive character which covered, amongst other methods, the employment of various processes of colour photography, and the making of a considerable number of exposures, elicited the fact that for the purposes in view a monochromatic rendering would be likely to prove more accurate in the results obtained, as well as more con-

venient for reproduction, and this being so the use of the Wratten panchromatic plate which is, as is known, sensitive to the rays of the whole of the visible spectrum, in conjunction with the Wratten K3 filter (which cuts out the ultra-violet rays and reduces the effect of the violet and blue rays to an extent proportional to the sensibility to such of the plate), was after further trials, finally decided upon as affording the most perfect means of securing in the desired monochromatic form a truly accurate representation of the coloured objects selected for the purpose of the tests, in their correct tone values as seen by the eye.

The experiments, which consisted in the photographing of a number of coloured ribbons (portions of which are exhibited before you), firstly by daylight and subsequently by the light of different artificial illuminants, and the recording of the visual changes noticed in the appearance of such and of other coloured objects (also exhibited), when viewed under the different lights, were carried out in a room measuring 16 ft. 6 in. long, 10 ft. 6 in. wide, and 9 ft. 6 in. from floor to ceiling. The walls on three sides were, with the exception of the two narrow doorways, fitted to a height of 7 ft. 6 in. from the floor with partitioned shelves containing correspondence filed in medium green covers. The average daylight illumination measured vertically on the shelves was 4·64 foot-candles, and the average surface brightness 1·4 foot-candles. The fourth side was almost entirely occupied by the window, which was provided with a light-tight shutter for the purpose of excluding the daylight when required ; and, for use in the daylight exposures, shading blinds for the purpose of varying the intensity of the lighting in the manner usually adopted in photographic studios. The frieze above the shelves and the ceiling were whitewashed, and presented a good diffusing surface, and the position of the easel containing the ribbons, which were suitably mounted for the purpose, and the camera by which the photographs were taken (neither of which were moved during the whole series of exposures) were as shown in Fig. 2.

The designation of the colours of the eleven silk ribbons used (each of which was specially selected as representing a tint commonly met with in the productions previously referred to), as defined by Mouat Loudan, Esq., the Principal of the Westminster Art School ; the percentage of light reflected by them when viewed by bright, diffused daylight, as ascertained by the "Lumeter" photometer, and as independently determined for the author by Mr. J. S. Dow, one of the inventors of the photometer used ; and the analysis of their colour constituents expressed in accordance with the nomenclature of Lovibond, determined by the absorptive method by the "Tintometer" colour box, and confirmed by independent tests made for the author by The Tintometer, Ltd., at their colour laboratories at Salisbury, were as shown in Table I.

The ribbons were stretched side by side upon a board in the order shown in Fig. 3 (reading from left to right), and were mounted upon the easel in the position shown in Fig. 2.

In the case of each illuminant the intensity of the illumination actually obtained upon them was (although the variation in the individual readings was quite insignificant) taken as the mean of five measurements made with considerable care, one at the centre and the others at points 4 in. either way from each of the four corners. The standard lamp in the photometer was carefully re-checked and adjusted immediately prior to the making of the tests ; a low reading ammeter and voltmeter were used in connection with the accumulator supplying current to it, and due precautions were taken to ensure a high order of accuracy in the results.

The final series of photographs were taken on September 8th last, exposures being made by the light from :—

(*a*) Bright, diffused daylight.
(*b*) Inverted arc lamp.
(*c*) Enclosed arc lamp.
(*d*) Metallic filament incandescent lamps.

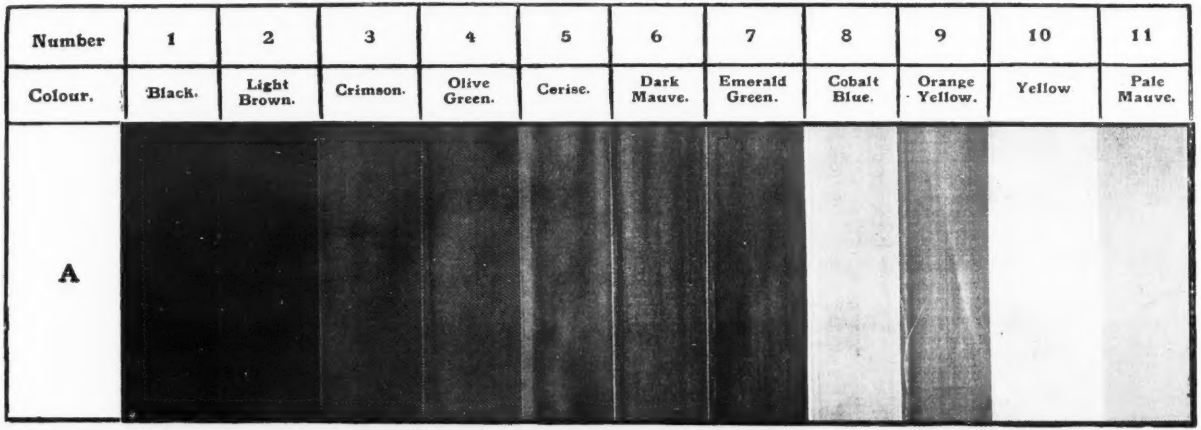


FIG. 4.—Photograph taken by Bright Diffused Daylight.

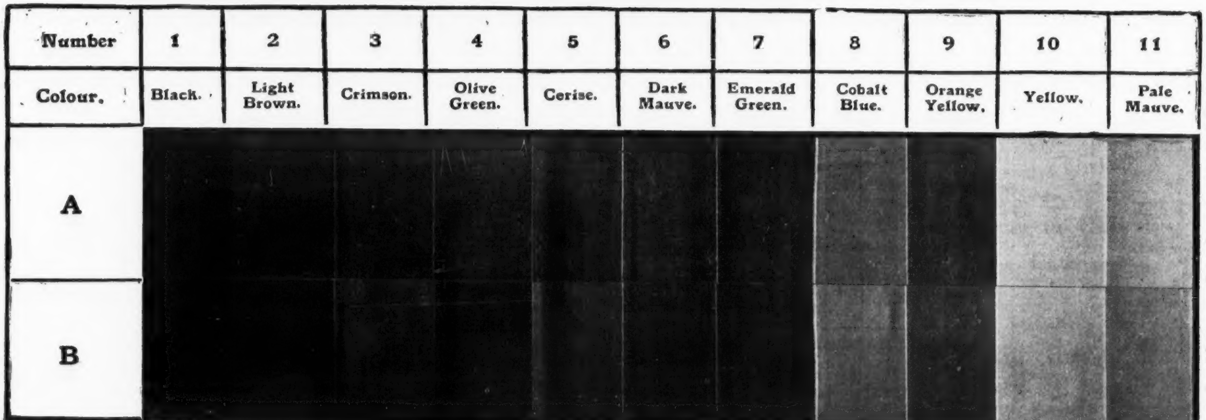


FIG. 5.—Photographs taken by (A) Bright Diffused Daylight and (B) Light from Inverted Arc Lamp.

(*e*) Carbon filament incandescent lamps.
(*f*) Inverted incandescent gas burners.
(*g*) Ordinary batswing gas burners.

TABLE No. I.

No.	Colour	Percentage of Light Reflected (Daylight Illum. 5-6 Foot Candles)	Colour Analysis — Lovibond's Nomenclature. Light Brighter than Standards	Matching Standards			Tests by Tintometer Colour Box. Colour Developed.		
				Red	Yellow	Blue			
1	Black	3·0	—	12·0	12·5	14·0	Black 12·0	Green ·5	Blue 1·5
2	Light Brown	6·3	—	11·5	11·0	7·8	Black 7·8	Orange 3·2	Red ·5
3	Crimson	8·2	—	21·5	3·2	2·1	Black 2·1	Orange 1·1	Red 18·3
4	Olive Green	10·5	—	3·8	17·0	7·4	Black 3·8	Green 3·6	Yellow 9·6
5	Cerise	12·0	—	23·0	1·65	—	Orange 1·65	Red 21·35	—
6	Dark Mauve	8·5	—	8·4	·7	5·0	Black ·7	Violet 4·3	Red 3·4
7	Deep Emerald Green	9·5	—	—	9·0	10·2	Green 9·0	Blue 1·2	—
8	Cobalt or Sky Blue.	21·0	—	—	1·05	8·4	Green 1·05	Blue 7·35	—
9	Deep Orange Yellow	33·0	N.T. ·02	10·4	7·6	—	Orange 7·6	Red 2·8	—
10	Yellow.	60·0	—	5·0	9·6	—	Orange 5·0	Yellow 4·6	—
11	Pale Mauve	45·0	—	2·8	·4	2·2	Black ·4	Violet 1·8	Red ·6

(*h*) Yellow flame arc lamp.
(*i*) White flame arc lamp.
(*j*) Mercury vapour lamp.

The lens used, the extent to which it was stopped down, and the correcting filter, and make of plate used, remained constant throughout the series of exposures, and were as follows :—

Lens.—Goerz patent double anastigmat, having a focal length of 16 in. and a full aperture of F7·7.

Stop.—F16.

Filter.—Wratten & Wainwright K3.

Plate.—Wratten & Wainwright panchromatic backed.

The exposures were at the suggestion of C. E. Kenneth-Mees, Esq. D.Sc., who is recognized as one of the foremost authorities on the construction of light filters and the photography of coloured objects, in each case so proportioned that, ignoring altogether the *colour* of the incident light, and assuming I to represent

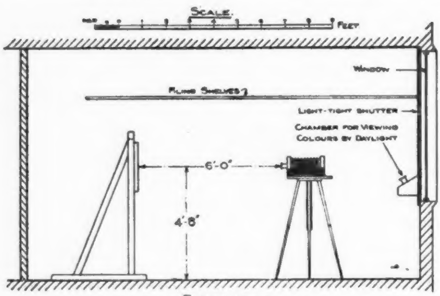
the intensity of the mean illumination in foot-candles, and E the time of exposures in minutes, $I \times E = K$, the latter symbol representing a constant equivalent to the product of the intensity in foot-candles of the mean illumination on the ribbons when photographed by daylight, multiplied by the time of exposure in minutes, found by an accurately graded series of test exposures to give the most perfect rendering of the whole range of colours. A pure white test surface (not shown in the reproductions) was also included within the limits of each plate, and it may be stated as instancing the remarkably uniform effect of the exposures, that the relationship between the average density or degree of opacity of this portion of each of the negatives, and that of the portions representing certain of the colours used, (again determined by tests made with the lumeter in a manner approved by Mr. Dow) is practically uniform.

The plates were developed by time and in total darkness, with a developer freshly and accurately compounded exactly in accordance with the formula published by the makers of the plates, and used at a temperature of 70° Fah., and were thereafter rinsed, fixed, washed, and dried together.

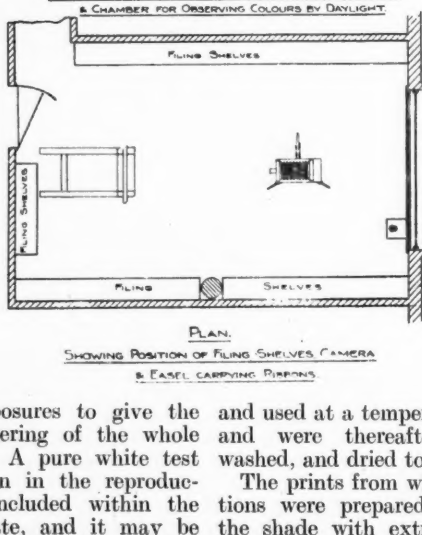
The prints from which the reproductions were prepared were printed in the shade with extreme care and to the indication of a print-meter, and were simultaneously washed, toned, fixed, washed again, and dried for the purpose of obtaining the requisite degree of uniformity.

FIG. 2.

PLAN & ELEVATION OF ROOM IN WHICH TESTS WERE MADE.



ELEVATION.
SHOWING POSITION OF CAMERA EASEL CARRYING RIBBONS & CHAMBER FOR OBSERVING COLOURS BY DAYLIGHT.



PLAN.
SHOWING POSITION OF FILING SHELVES CAMERA & EASEL CARRYING RIBBONS.

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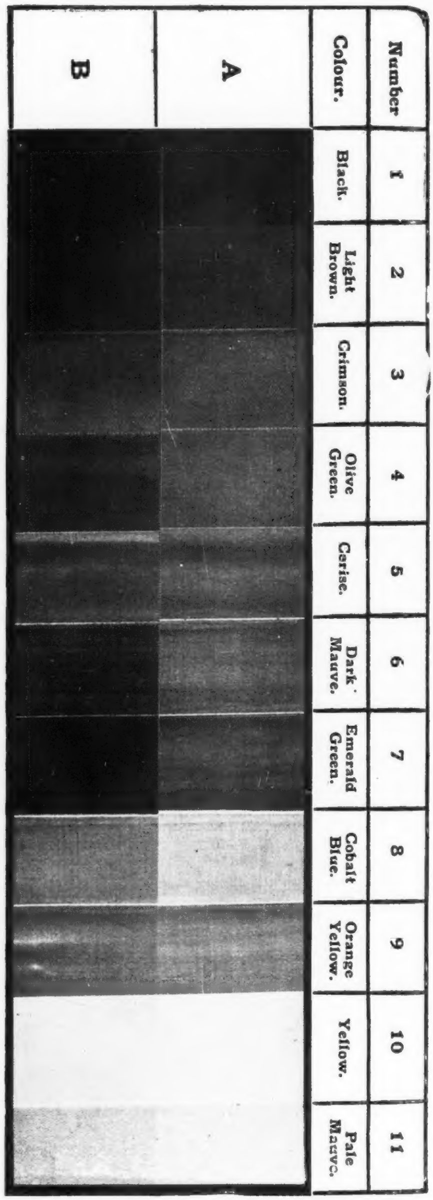

FIG. 6.—Photographs taken by (A) Bright Diffused Daylight, and (B) Light from Enclosed Arc Lamp.

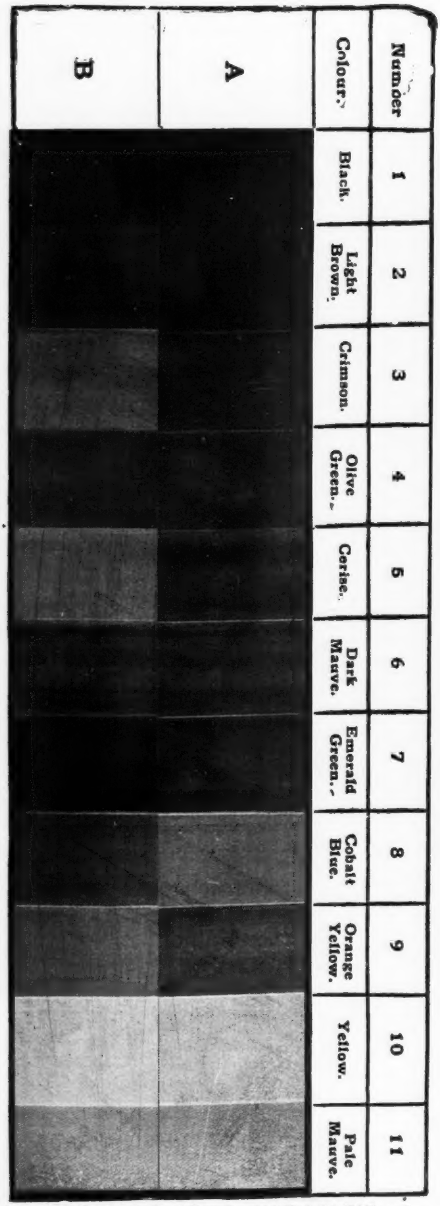

FIG. 7.—Photographs taken by (A) Bright Diffused Daylight and (B) Light from Metallic Filament (Tungsten) Incandescent Electric Lamps.

Number	1	2	3	4	5	6	7	8	9	10	11

ffused
d Arc

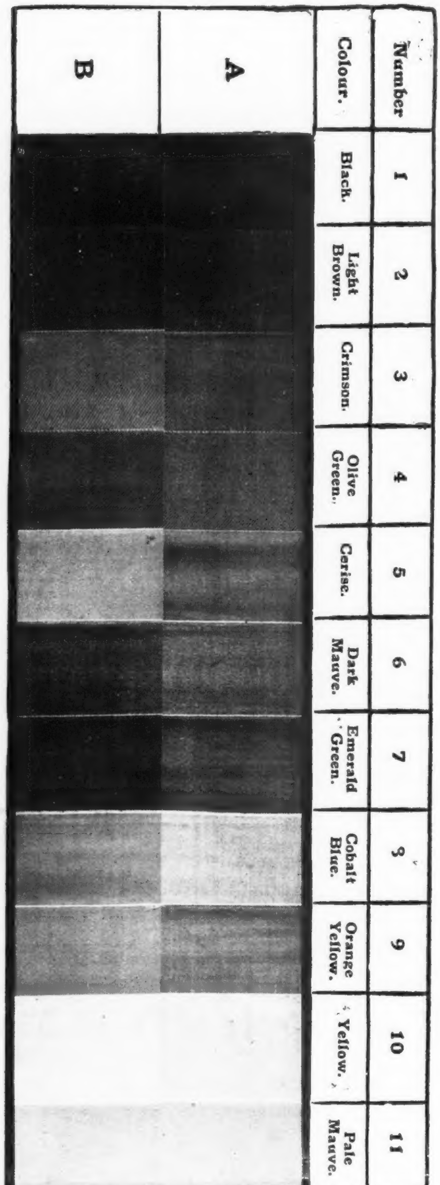

FIG. 8.—Photographs taken by (A) Bright Diffused Daylight, and (B) Incandescent Gaslight (Inverted Mantles).

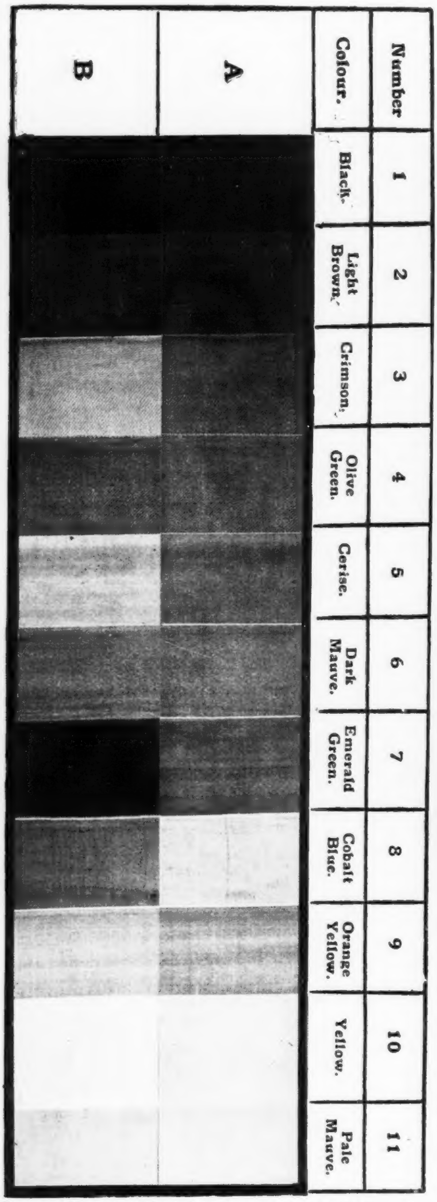

FIG. 9.—Photographs taken by (A) Bright Diffused Daylight, and (B) Light from Carbon-Filament Incandescent Electric Lamps.

Fig. 4 shows the daylight photograph, which was taken by bright, diffused daylight between the hours of 12 noon and 1 p.m. It will be noticed how well the respective colours stand out, how marked is the differentiation between the various tone values (even in the darker shades), and how distinctly the texture of the ribbons and the slight light and shade effects upon them are reproduced.

FIG. 3.

SHOWING POSITION OF RIBBONS ON MOUNTING BOARD.

1	2	3	4	5	6	7	8	9	10	11
BLACK	LIGHT BROWN	CRIMSON	OLIVE GREEN	CERISE	DARK MAUVE	EMERALD GREEN	COBALT BLUE	ORANGE YELLOW	YELLOW	PALE MAUVE

The tone values shown in this photograph are considered as standard in the comparisons which follow ; just as good well-diffused north light may be taken as a standard of daylight, and usually is so taken by those in the habit of using colours.

Fig. 5 shows a strip cut from the photograph taken by the light of the inverted arc lamp, placed adjacent to a strip from that taken by daylight, as shown in Fig. 4. The lamp was of the special but now well-known " OI " pattern, was one of four burning in series on a 220-volt direct current circuit, had a watt consumption (at the lamp terminals) of 430 watts, an arc voltage of 43 volts, and was burning the special carbons sold by its makers for use in inverted lamps.

The tone values representing the whole of the various colours are, it will be seen, in extraordinarily close agreement with those of the daylight rendering, and as such values undoubtedly correspond to the tone values of the actual objects as seen by the normal eye, they render self evidentthe extremely colour-true character of the light by which they were obtained.

With the exception of a very slight brightening of the reds (3 and 5) and an equally slight darkening of the pale mauve (11), which could only be detected by careful observation, not only every colour, but every shade of colour in the series, appeared absolutely unchanged in hue or intensity, thus quite bearing out the uniformity shown in the photograph.

Fig. 6 shows the photograph taken

by the light of the enclosed arc lamp again compared with the daylight rendering. The lamp was of the single enclosed long-burning type, as largely used for the interior illumination of drapery establishments, was one of a pair burning in series upon a 220-volt direct-current circuit, had a watt consumption (at the lamp terminals) of 390 watts, an arc voltage of 78 volts, and was burning pure carbons of the best quality. The tone values shown differ decidedly from those obtained by daylight, and the following changes in the appearance of the colours were noted: brown (2) darkened, reds (3 and 5) lightened slightly, greens (4 and 7) darkened considerably, purple, blue, orange, yellow, and mauve, all darkened slightly.

Fig. 7 shows the photograph taken by the light of the metallic filament (tungsten) incandescent electric lamps compared with the daylight rendering. The lamps were unobscured (*i.e.*, had bulbs of clear glass) and unshaded, were each rated at 55 watts, and were run upon a 220-volt direct-current circuit, the pressure of which was carefully watched, and remained practically constant throughout the tests and the exposure.

The tone values obtained differ from the daylight values to a slightly greater extent than in the case of the photograph taken by the light of the enclosed arc lamp, as shown by Fig. 6; but, whereas in the latter case the greatest differences were evident in the brown, the greens, and the blue, in this instance the colours most affected were the reds (3 and 5,) the emerald green (7), and the orange (9). The changes noted were as follows: Brown (2), lightened slightly and changed to reddish tint; reds (3 and 5), lightened many shades; emerald green (7), darkened and made yellower in tone; blue (8), darkened and changed to a purplish hue; and orange (9), brightened many shades.

Fig. 8 shows the photograph taken by incandescent gas light compared with the daylight rendering. The burners were of the inverted type and were quite unshaded. The gas supply, which was ample in capacity, was taken from the low-pressure supply mains of the South Metropolitan Gas Co. The pressure, which was not measured, was apparently fairly constant. The variation between the tone values obtained, and those of the daylight rendering, differs but little from that evident in the photograph taken by the light of the metal filament lamps, as shown by Fig. 7, and there would appear from the observations made to be no question but that, at all events when both are new, the light given by a good inverted incandescent gas mantle is, as regards its colour-revealing properties, upon the whole quite as satisfactory—or perhaps more correctly, is not more unsatisfactory than that of an equally good metal filament incandescent lamp, and is decidedly superior to that of the carbon filament incandescent lamps experimented with.

The colour changes noted were as follows: Brown (2), darkened; reds (3 and 5), lightened many shades; mauve (6), darkened; emerald green (7), darkened and made yellower in tone; blue (8), darkened and changed to a more navy blue; and orange (9), brightened many shades.

Fig. 9 shows the photograph taken by the light of the carbon filament incandescent electric lamps, compared with the daylight rendering. The lamps were unobscured (*i.e.*, had bulbs of clear glass) and unshaded, were each of 32 c.-p., and were run upon the 220 volt direct current circuit previously referred to.

As might be expected, the tone values obtained differ from the daylight values to a much more marked extent than in the case of the metallic filament lamps, and the light is, as is generally recognized, still less perfect as regards its colour-revealing properties.

The colour changes noted were as follows: Brown (2), reddened in tint; reds (3 and 5), lightened many shades; mauve (6), changed to a pinker tint; emerald green (7), darkened considerably and made yellower in tint; blue (8), darkened and changed to a much more purple blue; orange and yellow (9 and 10), brightened and changed to a deeper orange; and pale mauve (11), darkened slightly and changed to a pinker tint.

Fig. 10 shows the photograph taken by ordinary gas light compared with that obtained by daylight. The burners used were "Bray's" No. 6. The gas supply was that used in the obtaining of the photograph by inverted incandescent gas light, and the burners were unshaded. The days of the luminous gas flame are so nearly ended that it is hardly necessary to dwell upon the colour changes noted, which were, however, as follows: Brown (2), reddened; reds (3 and 5), lightened considerably; greens (4 and 7), rendered yellower in tint; mauves (6 and 11), changed to a more rose-coloured tint; blue (8), darkened and changed to a more navy blue; and orange and yellow (9 and 10), brightened and changed to a deeper orange.

Passing now for a few moments from those illuminants more commonly used for interior lighting, to a light source which is perhaps now more widely used than any other for the exterior illumination of shop fronts—the light of the flame arc lamp.

The lamp was of the direct-current type, was one of four burning in series upon the 220-volt circuit previously referred to, had a watt consumption (at the lamp terminals) of 460 watts, an arc voltage of 46 volts, and was burning, in the case of photograph (*b*) white flame carbons, and in the case of photograph (*c*) yellow flame carbons.

The tone values in each case again differ distinctly, as might be expected, from those of the daylight rendering; but it is interesting to note that the results obtained with the white flame carbons are upon the whole much nearer, especially as regards the lighter shades, to those obtained by daylight than are those given by the yellow flame carbons.

The colour changes noted were as follows:—

White Flame.—Brown (2), brightened and changed to a slightly redder hue; reds (3 and 5), lightened many shades; greens (4 and 7), rendered yellower and lightened slightly; blue (8), changed to a much more intense blue; orange and yellow (9 and 10), changed to a deeper and more orange colour; mauves (6 and 11), changed to a bluer and darker shade.

Yellow Flame.—Brown (2), darkened slightly; reds (3 and 5), changed to a brick red; greens (4 and 7), deadened and rendered yellower; blue (8), darkened and changed to a more navy blue; orange and yellow (9), changed to a deeper orange; mauves (6 and 11), darkened considerably and changed to a purple tone.

Finally, Fig. 11 shows the photograph taken by the light from a mercury vapour lamp again compared with the daylight rendering. The lamp was used minus the outer glass shade, was burning singly upon a 220-volt direct-current circuit, and had a watt consumption of 345 watts. The effect of the light upon the colours was, needless to say, extraordinary. Almost all appeared to be curiously flattened or deadened, quite apart from the actual colour changes, which, as far as they could be described, were as follows: Brown (2), changed to green; reds (3 and 5), changed to almost black; greens (4 and 7), lightened considerably; blue (8), deadened; orange and yellow (9 and 10), changed to a greenish yellow; mauves (6 and 11), changed to a slate-blue grey.

It should be noted that both the incandescent lamps and the gas mantles used were new, the former being put into use for the first time upon the occasion of the tests and exposure, and the latter being previously used only for the time necessary for the getting rid of the reddish tinge characteristic of certain mantles when first ignited, but which disappears after a few hours' use, as there is little doubt but that the colour distortions produced by their light, would tend to become more pronounced with age.

The mercury vapour lamp was, it is also only fair to state, included amongst the lights dealt with, not in view of any claims by its manufacturers as to its suitability for use in processes requiring colour discrimination, but merely for the purpose of indicating the extreme extent to which colours are changed by a light possessing in itself perhaps the nearest approach to a monochromatic spectrum of any yet available.

The actual changes observed have for the purpose of ready reference been assembled in tabular form.

This Table shows at a glance the direction in, and. in conjunction with the photographs (which should only be considered with it), to some degree, the extent to which, each of the illuminants considered meets, or fails to meet as the case may be, the practical requirements artists, designers, and those engaged in the drapery, textile, printing, and furnishing trades, but also of those requiring artificial light for such diverse purposes as—to instance only a few of the many directions in which a practically colour-true light is, or ought to be, essential—the tinting and printing of wall-papers,

TABLE 2.

CHANGES IN THE APPEARANCE OF COLOURED OBJECTS UNDER DIFFERENT LIGHTS.

Description of Light Used	Appearance	Colour					
		Brown	Red	Green	Mauve	Blue	Orange & Yellow
Bright Diffused Daylight	Bluish White or Pure White	Normal	Normal	Normal	Normal	Normal	Normal
Inverted 'O.I.' Arc Lamp	Bluish White or Pure White	Normal	Slightly Brighter than Normal	Normal	Slightly Darker than Normal	Normal	Normal
Enclosed Arc Lamp	Bluish White	Darkened	Lightened Several Shades	Darkened Considerably	Darkened Slightly	Darkened Slightly	Darkened Slightly
Metallic Filament Inc.d Lamps	Yellow White	Lightened & changed to Reddish Tint	Lightened Many Shades	Darkened & Changed to a Yellower Tint	Changed to Redder Tint	Darkened & Changed to Purplish Colour	Brightened & Changed to a more Orange Shade
Inverted Incandes'nt Gas	Greenish Yellow	Darkened	Lightened Many Shades	Darkened & Changed to a Yellower Tint	Darkened & Changed to a Redder Tint	Darkened & Changed to a more Navy Blue	Brightened Many Shades
Carbon Filament Inc.d Lamps	Orange Yellow	Reddened in Tint	Lightened Many Shades	Darkened & Changed to a Yellower Tint	Darkened & Changed to a Pinker Tint	Darkened & Changed to a much more Purple Colour	Brightened & Changed to a deep Orange
Ordinary Gas Light	Yellow	Reddened in Tint	Lightened Considerably	Changed to a Yellower Green	Changed to a Pink Rose Coloured Tint	Darkened & Changed to a more Navy Blue	Brightened & Changed to Orange
White Flame Arc Lamp	Bluish White	Slightly Reddened in Tint	Lightened Many Shades	Changed to a Yellower Tint & Lightened Slightly	Changed to a Bluer & Darker Shade	Brightened & Changed to a more Intense Blue	Changed to a deeper & more Orange Colour
Yellow Flame Arc Lamp	Deep Yellow	Darkened Slightly	Changed to a Brick Red	Deadened & Changed to a Yellower Colour.	Darkened Considerably & Changed to a Purple	Darkened & Changed to a more Navy Blue	Changed to a deeper & more Orange Colour
Mercury Vapour Lamp	Pale Blue-Green	Changed to a Greenish Colour	Changed to almost Black	Lightened Considerably	Changed to a Slate-Blue Grey	Deadened	Changed to a Greenish Yellow

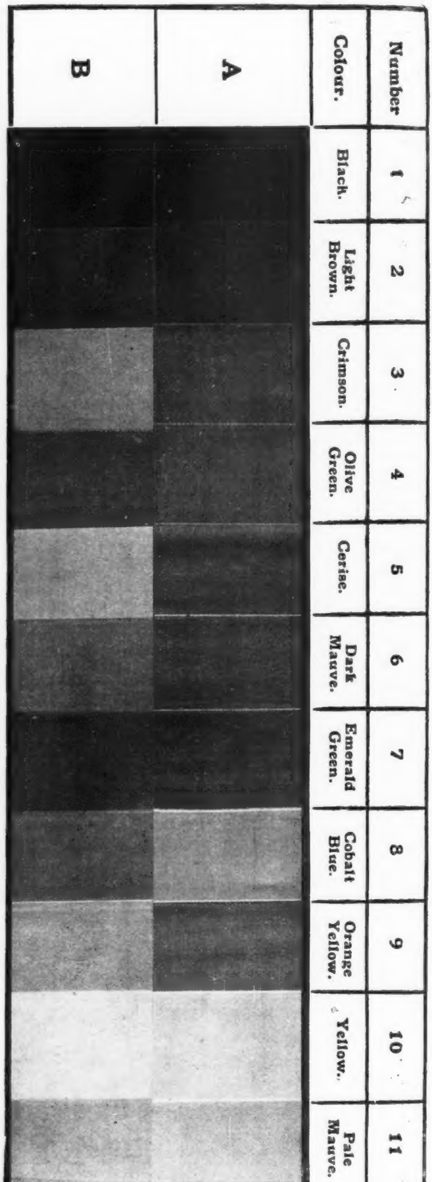

FIG. 10.—Photographs taken by (A) Bright Diffused Daylight, and (B) Ordinary Gaslight (Open Flame Fish-Tail Burners).

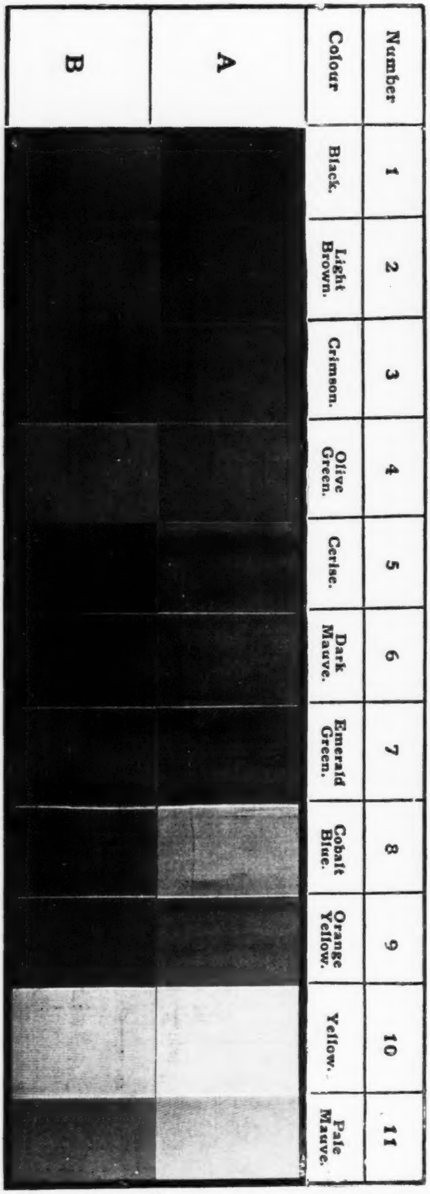

FIG. 11.—Photographs taken by (A) Bright Diffused Daylight, and (B) Light from Mercury Vapour Lamp.

three-colour process work, lithographic printing in colours, and the printing of tin for the manufacture of the multifarious coloured boxes and canisters now so extensively used. The lighting of florists' shops, the manufacture of paints and distempers, the painting of china and pottery, the grading of sugar and starch, the selection of tobacco leaf for the wrapping of cigars, the manufacture of stained glass, the grading of diamonds and other precious stones, and the matching of artificial teeth.

It also makes manifest the fact that the inability to secure a really satisfactory, steady, uniform, and sufficiently colour-true light, capable of being maintained at a constant intensity for an unlimited period, and which is in this respect a distinct advance on daylight, the extreme variability of which is well known, cannot longer be legitimately put forward as an excuse for confining classes for the teaching of oil and water-colour painting, designing, &c., to the hours of daylight, or keeping art galleries and museums containing expensive collections closed after sunset, and immediately proves that failing the use of a colour-true artificial light, the decoration of rooms is, as regards its effects, directly dependent upon the character of the light used for their illumination, and emphasizes the need for that closer co-operation between the decorative craftsman and the illuminating engineer which the author has previously* advocated.

The results may also prove of considerable value to those interested in the photographing of interiors by artificial light, and will probably go far towards explaining many of the apparent mysteries so frequently met with in this connection.

No attempt has been made in the compilation of these notes to deal with the subject in an ultra-scientific or mathematical manner, the simplest possible language and a more or less popular method of treatment having on the contrary been deliberately selected as likely to render such benefits as may accrue from the work carried out to the greatest possible number of actual light users, nor is it suggested (further confirmatory experiments being still in progress), that, owing to the exigencies of modern dyeing, colours generally similar to those dealt with, but differing therefrom in the particular manner in which they have been produced, would, under similar treatment, of necessity give identical results, although generally they would, it is thought, be found so to do.

* *Illum. Eng.*, June, 1911, p. 365.

The problem is capable of being dealt with in a variety of ways. The relative luminosities might be compared by examining the objects under the different lights, and determining the variation in the percentage of light reflected. The reflected light might be examined spectroscopically and possibly spectragraphs obtained (a method which the author is just commencing); or it may, as colour photography is improved, be found possible by its means to record in colour, with sufficient accuracy, the actual changes in the appearance of the objects. Any or all of these methods would prove most interesting, and it is hoped that the results so far obtained from the experiments described, may not only lead to an interesting and profitable discussion upon this occasion, but may stimulate others to further and more ambitious efforts, to the mutual advantage of all concerned.

In conclusion, the author desires to express his indebtedness to the following: Mr. J. S. Dow, and The Tintometer, Ltd., for assistance in the directions previously indicated; Mr. J. Stuart Ker, and Mr. M. Loudan for assistance in the determination of the colours of the ribbons used, and for their kindness in providing interesting examples of the matching of artist's colours under different lights; Dr. C. E. Kenneth Mees for his assistance in suggesting the method of most correctly rendering the colours and the determination of the exposures; Mr. W. H. Watkins for assistance as to the determination of the exposures; Dr. J. A. Harker and Mr. T. Smith, of the National Physical Laboratory, the former for information as to the light composition of the spectrum emitted by the various sources, and both for assistance in connection with the analysis of the colours used;

Messrs. The Union Electric Co., Ltd., for the use of their testing laboratory and equipment; Mr. C. H. Champion, for assistance in the making and recording of the various observations, and the various firms who have kindly placed at his disposal for the purpose of the experiments, the coloured objects exhibited bearing their respective names.

Discussion.

THE CHAIRMAN, after expressing the thanks of the meeting to the author, referred to a point in the paper with reference to using a filter with an arc lamp, thus rendering the light practically equivalent to daylight for colour discrimination purposes. He said there seemed to be no reason why similar filters should not be designed to enable other forms of illuminant to give an equally truthful colour discrimination.

He would have been interested if Mr. Ritchie had been able to include in his experiments high-pressure gas lighting, because the light from this source had a greater whiteness than low-pressure gas. He would be interested to have some experiments carried out in that direction. They need not be surprised at the results with the mercury vapour lamp, because if they looked at themselves by the light of this lamp, they would certainly come to the conclusion that there was something wrong with the colour discrimination value of that light.

Later on in the discussion Dr. Kenneth Mees and Mr. Trotter would give interesting demonstrations of how to produce the equivalent of daylight by means of other methods of lighting than inverted arc lamps, but he would first call for discussion upon the paper.

MR. MOUAT LOUDAN of the Westminster Art School exhibited certain colours which he had copied by inverted arc lamps and by daylight, and in both cases the matching of the colours was very successful. He said that the greatest difficulty occurred in the orange, especially in the daytime, when it was rather more yellow and lost its pinky character somewhat; but the blue and the red were very good. Possibly the red was a little darker. This was all he had had time to experiment with so far, but he hoped to make some further tests later on.

MR. S. E. THORNTON said he was interested in the lighting of water-colour drawings and oil pictures in private and public galleries, and it seemed to him that the blue tones were the most difficult to get by artificial light. He understood that blues in daylight varied very much, according to the opacity of the atmosphere. Unfortunately, the atmosphere in London is thick, and for that reason some of our most valuable pictures can hardly be seen to their full advantage, even by ordinary diffused daylight, as the most beautiful and delicate blues were lost. He considered that everything should be done to encourage the blue rays, and apparently the inverted white flame arc lamp was the best light for this purpose. At the same time, he did not see why gas or incandescent electric lamps should not be used, even in conjunction with arc lights, for this purpose if the other rays were filtered to get the proper proportion of the blue rays, so as to represent daylight.

MR. V. H. MACKINNEY expressed his interest in the paper. There was a large section of the general public which considered expense of secondary importance provided good colour-discrimination was secured. In his work he had frequently been interested in these colour problems, one point being the effect on the colour of a source of using tinted shades. It was often essential to use a form of reflector which did not alter the spectrum of the light in any way. In this connection Mr. Mackinney demonstrated that a piece of Holophane glass did not affect the colour of light in transmission by holding it in the rays from a lantern.

While appreciating the care and skill devoted by Mr. Ritchie to the photographic method, he thought that actual demonstrations of the effects of various lamps on colours formed one of the readiest methods of presenting this matter before the general public. He had therefore arranged to exhibit three boxes from the Holophane laboratory, containing respectively carbon filament, tungsten, and mercury lamps, and showing side by side the comparative effects of these lamps on coloured ribbons. He had also equipped one of the boxes with a prism, enabling the spectrum of the lamp to be seen.

In conclusion, Mr. Mackinney showed several photographs taken with the Lumière plates, showing the appearance of coloured objects. One of these referred to some elegant silk shades in Gatti's Restaurant. The other showed the appearance of a bunch of flowers illuminated respectively by a tungsten lamp and mercury vapour lamp. He pointed out that, as Mr. Ritchie had said, it was extremely difficult to secure correct colour-rendering, as seen by the eye, by the aid of this method.

DR. C. E. KENNETH MEES said that, at the request of Mr. Ritchie, he had hurriedly prepared a slide to show the relation between the results obtained in recording intensities in monochrome when using Wratten panchromatic plates with a K3 filter, as compared with the visual intensities seen by the eye. The curve shown (see Fig. 1) was obtained by photographing a daylight spectrum on the panchromatic plate through a K3 filter, the plate being prepared on patent plate glass. Another piece of the same plate was exposed behind a rotating sector wheel, so that a known series of exposures was impressed upon it, and this second piece was developed with the spectrum negative. After drying, the optical densities of the spectrum negative were measured for each successive portion of the spectrum, and the densities of the sector wheel negative were also measured and plotted against the known exposures to form a curve. The densities of the spectrum negative were then interpolated on this curve, and the intensities for each successive portion of the spectrum could thus be obtained. The numbers so obtained were corrected for the dispersion of the spectrograph used and brought to percentages of the maximum intensity. They were then plotted and formed the solid curve shown in the figure, representing the spectral distribution of intensity as given by a Wratten panchromatic plate and K3 filter to daylight. The visual curve, shown broken in the figure, was taken from A. Konig's readings for a light of medium intensity.

It would be seen that the relative intensities of different colours, as perceived by the eye and by the plates and filter used by Mr. Ritchie, were very similar, the plate being slightly less sensitive to blue-greens, and slightly more sensitive to deep reds, than the eye; but the differences were so small as to be quite negligible in practice.

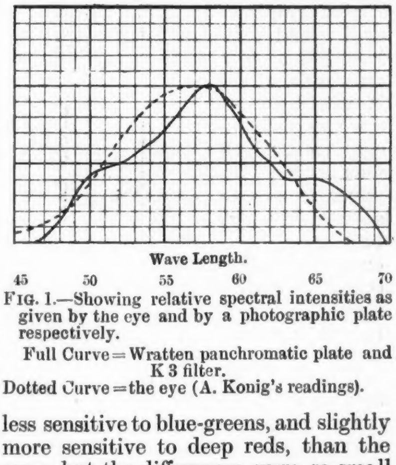

FIG. 1.—Showing relative spectral intensities as given by the eye and by a photographic plate respectively.

Full Curve = Wratten panchromatic plate and K 3 filter.

Dotted Curve = the eye (A. Konig's readings).

Dealing with the paper, he thought Mr. Ritchie failed most in showing differences in the greens. This was especially noticeable in the case of the incandescent gas compared with the Osram lamp; because any one who had worked at spectrum photography by incandescent gas and by metal filament lamps knew that in the former there was an emission band compared with the tungsten lamps. A tungsten lamp had a slight emission band in the green, but incandescent gas had a much greater one. The reason for the difficulty with the green was well known to all colour

photographers and people who reproduced colours for process work, and could be seen by looking at Mr. Ritchie's photographs. His greens were very dark. Now greens were naturally very dark colours. It was difficult to get a bright pure green, and as dark colours they came in the lower portion of the sensitiveness curve of the plate; and in most of Mr. Ritchie's photographs the greens fell into the portion of the plate where the plate did not correctly reproduce the intensity. A photographic plate only reproduced intensities correctly for certain portions of the possible range of exposures, and any dark colours which fell into the region of under exposure, as the greens would, were thereby rendered too dark. It was difficult to interpret strictly the results obtained by Mr. Ritchie, for, as he had said, the paper was not intended to be a purely scientific one, and for definite knowledge of the subject it would be necessary to know the spectral distribution of the light sources employed, which would complicate the matter very considerably. But the paper served its purpose most admirably in showing the effect which would be observed when different colours were examined under different artificial light sources. From this point of view it should be of very great use to the people for whom it was intended.

Mr. A. P. Trotter said that the subject of the paper was colour discrimination by artificial light, but the best part of it related to the representation of tone values by photography. This should be useful for those who were attempting to reproduce in black and white the tone values of pictures and other coloured objects. The general result was that, by means of the Wratten panchromatic plate and the K3 filter, it was possible to obtain excellent tone values with an inverted arc lamp, but all the other sources of light mentioned were practically useless for this purpose.

The author had attempted to describe various colours in terms of the Lovibond tintometer. That, no doubt, many of the members knew consisted of various coloured glasses, most carefully selected, by which colours could to a certain extent be described. But the description was a purely arbitrary one. The tintometer had certain blues, certain reds, and certain yellows, all of which were most complex in themselves, and he was afraid that the characteristics of the tintometer were not sufficiently known to make the author's descriptions of the colours intelligible to those who had not had access to such an instrument. He described emerald green as 9 parts green and 1·2 parts blue on the tintometer scale. The paint called emerald green is a definite chemical compound, an arsenite and acetate of copper. Maxwell used it as a standard, and simply called it emerald green. Ogden Rood describes it as having a dominant wave-length 523, and a luminosity or albedo of ·48. Church gives its luminosity as 48·6.

Mr. Trotter said that he had just begun to make some experiments upon a subject which was perhaps within the title of the paper, namely, 'Colour Discrimination by Artificial Daylight.' Twenty years ago he read a paper before the Institution of Electrical Engineers on 'Notes on the Electric Arc' (vol. xxi. p. 360, 1892), and gave the spectrum intensity curves of Abney for sunlight and for flat-flame gas light, which was practically the same as the carbon glow lamp, and for the electric arc. He showed that if they subtracted the one from the other, the difference was a representation of the absorption curve which had to be dealt with, and he was quite surprised that, after these twenty years, no one had worked out this important matter, namely, to reproduce artificial daylight. Dr. H. Ives and Mr. Luckiesh had recently attempted it, and their paper had been published in the Journal (vol. iv. July, 1911, p. 394). They spoke of it as the subtractive method, and gave curves representing daylight and the lights which were used. They set to work by taking cobalt glass, which was an unfortunate choice, because cobalt glass, although it looked blue, was really a very complex kind of blue—the spectrum of it contained four deep bands. The superfluous red was corrected by using a green glass, and then a screen stained with a red dye was added, and the light

which managed to get through was a fairly good daylight.

This was what he (Mr. Trotter) had been trying to do. As far as his test colours were concerned, he wanted to use colours which everybody could reproduce, and which everybody knew all over the world, namely, Messrs. Winsor & Newton's colours. The test-box which he exhibited was practically full of artificial daylight. Inside there was an electric lamp shining through a blue glass window on to a set of sample colours, which could be observed through a hole; and outside there was another set illuminated by daylight. As soon as he began experimenting he noticed how greatly the colour of daylight varies—at all events, in London. Having arrived at an apparently white light as a standard, he found the colour of the light on a grey day varied from hour to hour, and it would rather be a question, when he got a little further on, as to what sort of daylight he was going to call normal artificial daylight. He had been in doubt as to what sort of coloured screen to use. It appeared to him at first that the most scientific thing to do would be to apply to Dr. Mees, who was the highest authority on light filters; but Dr. Mees used stained gelatine, and although he (Mr. Trotter) might be quite wrong, he had a doubt about the permanence of blue dyes, and so he went to another firm of world-wide reputation, Messrs. James Powell & Sons, and asked them to supply him with samples of blue glass. They had kindly sent him a very large number of specimens, and he built a box, which he exhibited, in order to experiment with them. The spectroscope showed that they were all varieties of cobalt glass, but experiments with them were interesting. No. 136 gave a very good white at one time, at another it showed a very pale yellow, but a few hours later he found it gave a pale blue light. No. 141 was another very close match, sometimes a little blue, and sometimes a little yellow. Having got a fair match for white, he tested various colours in succession. He knew that he would meet with difficulties, because he was using cobalt glass. Some colours behaved very well, whilst others did not. He was now going on with this work, and was hoping to get other kinds of glass which would give better results. He hoped, in connection with this, to make spectro-photometric examination, not only of the blue glass screens, but of the colours of artists' materials. This should throw some light on their appearance under artificial illumination.

Mr. Lovibond asked Mr. Ritchie whether the calculation of his candle-power was based on the inverse of the squares of distance, or whether it was a physiological value according to visual perception. The difference between the two was so great that only those who have worked on the subject can realize it. For instance, with 1 foot-candle at a foot distant from the white screen, it would register a luminous intensity of 26 physiological units in the tintometrical scale of light absorbents; whilst, if they added another candle to it, under the law of the inverse of the squares of distance, this value would be theoretically doubled; but, as an experimental fact, the second candle only added 3 additional units, and each additional candle up to four only added 3. One difficulty that he had in dealing with the question was that the coloured ribbons were nearly all complex, and in order to form a judgment it was necessary to get the physiological energy of the composing pure colours, and that could only be got by measuring them according to a scale of colour absorbents. There was no difficulty in doing that as far as most lights were concerned.

It seemed to him that three factors had to be dealt with. First, the intensity, because the power of visual perception varied for different intensities, and constancy could not be relied on beyond 28 physiological units, and they had only to look at the orange fabric curved on the edge of the table, for instance, in order to realize the importance of light intensity variations. Then there was the question of variations in the angle of light incidence producing colour variations. Take the surface of fabrics such, for instance, as

the ribbons which had been dealt with. A variety of tints on each ribbon could be produced by changing the number of angles of incidence, and this specially applied to the smooth fabrics, such as the satins. It was of the utmost importance that that should be observed.

Concerning the use of artificial light, his ideal had been to produce a light which would give colour measurements in accord with those of diffused daylight—this has been done in some instances—and he thought it was possible to do it in all. The difficulty in measuring colours by artificial light was so extreme that unless they got a standard to refer to—and he was convinced that at present diffused daylight was the best—it was impossible to arrive at what he considered quantitative results without a standard of constants. It follows that in order to recover a given colour it must have been compared to a scale of colour constants under a given set of conditions of observation. Apart from these conditions, it might be said that the record of colour rests only on what he considered to be a memory of a sensation. It must be brought to a mechanical scale in order to be recoverable at will.

Dr. Edridge Green said he had a few remarks to make on photometry which would probably astound people interested in it. Mr. Ritchie and others had shown the difference obtained with an arc light and daylight, which latter, as Mr. Trotter had said, was extremely variable. For instance, at midday daylight reflected from a white cloud was fifty times the intensity of that in the morning. The importance of the perception of relative difference was a point of view which was very generally overlooked. For instance, if they took a sheet of printed paper, the white light reflected from the black type was about one-fifteenth of the light reflected from the white paper. At midday, fifty times as much light was reflected from the white as in the morning, whilst the black type was actually reflecting nearly 3¼ times more light than the white by morning light. Again, if they held up a piece of grey paper in front of a window in a room with whitewashed walls that paper would look grey, though it was reflecting far more light than the light which was reflected from a corresponding area of the wall.

Passing on to the question of colour, he said that, supposing they took a Bouguer photometer and put a piece of ultramarine paper on one side and a piece of common brown paper on the other, and illuminated the brown paper by daylight and the ultramarine paper by gas light, it would be found that they could easily make the ultramarine paper and the brown paper appear identical. If they examined the ultramarine blue paper, however, in exactly the same gas light, the paper appeared blue, so it was clear that there were some very definite physiological conditions which had to be taken into consideration.

In his opinion the discrimination of colour, both by daylight and artificial light, was very much more limited than was usually supposed. An ordinary normal person could see only 18 distinct differences in the spectral range. If they had a mixed light or imperfect methods, or allowed variations of intensity, then they would see more differences. They could observe this by isolating a small area of the spectrum as in his spectrometer, and viewing it with a double-image prism. By that means they could get two rectangles of spectral light which appeared identical; but, if they moved the double-image prism so that one image was brighter than the other, then the two images were no longer alike in colour. Physiological conditions were such that in most cases they produced a change which was for our benefit.

Mr. Justus Eck said he had arranged with an artist, Mr. Booth, to paint a picture partly by daylight and partly by the aid of the "OI" inverted type arc lamp. The picture was painted on four occasions, and after each session the colour box and palate were cleaned, as well as the brushes, and the artist started afresh. He had nothing to guide him, the picture being one of original conception. He had the pic-

ture at the meeting, and showed it illuminated by a picture-illuminating device designed by Mr. Mackinney, and he pointed out how difficult it was to detect any difference in the colours, half of the picture having been painted by inverted arc light and the other half by daylight. He thought this was a very good result, in view of the fact that light filters had not been used, and it demonstrated what Mr. Ritchie had pointed out, namely, that he was not seeking for a special lamp for occasional discrimination of colours and comparison matching, but a form of illumination that would be applicable everywhere to every place in quite a simple manner.

Mr. Haydn T. Harrison, whilst congratulating Mr. Ritchie upon his paper, said he hoped that he would never succeed in finding the lamp which Mr. Eck had said he was looking for, namely, a lamp which absolutely always gave daylight. He thought Mr. Ritchie summed the question up rather tersely when he stated that "the ultimate appeal of all such articles as the beautiful present-day fabrics, carpets, wall papers, pottery, &c., is attributable to a peculiar chain of physiological and psychological events, which, whilst fully recognized, cannot altogether be explained." Mr. Ritchie had not, of course, explained them, because he had left such considerations out altogether, and had gone, as far as he could see, for the actinic method of testing, *i.e.*, he had relied on the degree to which the reflected light from the various colours affected the chemical value of the plates that he was using; but he thought that a certain amount of colour discrimination was necessary, and this method rather lacked that discrimination by artificial light. This was unfortunate, as artificial light had become part of our everyday life.

Even now, if a lady wished to purchase fabrics which were for an evening dress, she would purchase them in a light similar to the one in which she would wear them—in fact, the best drapers had artificial light matching rooms. If a lady purchased by daylight a dress for evening wear, she might be very disappointed with it. The way to deal with the matter was to have—and he hoped they would always have—a certain degree more yellow light when daylight had gone; and therefore the dresses they were going to wear, and the pictures they were going to look at, ought all of them to be designed for that artificial light that we should probably have for many years hence. Therefore, he had always thought that, even in dining-rooms, if there were any pictures, it was very much better to have that class of picture which had been painted for artificial light.

He had often wondered how an artist painted a picture of an interior lighted by incandescent lamps in his daylight studio. It seemed that he had to imagine a very great deal or light part of his studio with the light by which the picture would be illuminated, and if he did it by the "artificial daylight" lamps that we were going to get, the picture would not have the appearance of being an interior lighted by artificial light, and therefore he did not see that colour discrimination from this point of view was going to be of much use. He could, however, realize the value of it from a commercial point of view, where a certain amount of work had to be done by daylight, and therefore it would be an advantage to have it prolonged into the hours of darkness.

The Chairman said that he would ask Dr. Kenneth Mees to put before the meeting the results of some researches which he had made on the production of artificial daylight.

Dr. Kenneth Mees said that about six years ago he wanted a source of artificial daylight for his own work in the measurement of the sensitiveness of photographic plates. The majority of plates were exposed by daylight, and it was therefore necessary to test them by a light as similar to daylight as possible. Originally he had made a filter by means of dyes adjusted to follow a spectro-photometer curve. But it was unsatisfactory in many respects. It was unstable, it

had to be made up just before it was used, and it was not very accurate. At intervals ever since he had been working on the problem, and two years ago he succeeded in making the filter he wanted for photographic work. It was an extremely good filter and quite satisfactory, except that it was not quite permanent, although it was permanent enough for his purpose when it was not exposed to sunlight.

That was two years ago, but it had since occurred to him that there were other people who wanted a daylight lamp for other purposes, and he set to work to see if he could make a filter which would not only give him the light he required, but which would also contain only permanent dyes. Up to recently there had been no satisfactory blue, and this hindered the work for some time, until the dye works produced a blue dye which was quite permanent. This blue had been exposed to bright south sunlight in Germany for a long time without any change, and it had also been exposed to the quartz lamp for long periods. He had thus been able to make a good filter with the aid of dyes only. Any filter involved, however, a very considerable loss of light—about 15 per cent of the candle-power only being given. Dr. Mees exhibited a sample of the lamp, and showed the effect of it upon pictures compared with an ordinary metal filament lamp. He said that daylight was fairly constant in colour in the country, provided it was merely reflected from white clouds, and he had taken cloudy daylight at midday or early afternoon as being the standard. The practical difficulties of making the filter were considerable.

Mr. L. Gaster mentioned that he had received a letter from Dr. Ives, one of the Society's Corresponding Members, who had been very much interested in the problem referred to by Dr. Mees. Six or seven months ago Dr. Ives had visited him and explained a good deal of what he and Mr. Luckiesh had been doing, and that was reported in the Journal. Since then he had made other experiments, and hoped to replace the gelatine screen by two coloured glasses. He had expressed his great interest in Mr. Ritchie's paper, and had hoped to send some sample filters for exhibition, but they had not yet arrived.

The practical problems referred to by Mr. Ritchie were of considerable interest in many trades. He knew of two or three, such as dyeing and cleaning, where the work was absolutely suspended after four o'clock, owing to the deficiency of daylight. There were some colours which admittedly could not be matched and compared by ordinary artificial light, but there were other less delicate shades with which work might be done. It would be very valuable to classify colours in this way. Again, if it were possible to make a certain number of dyed or painted charts to indicate to a likely customer what the appearance of a series of colours would be by various illuminants, this, too, would be a most valuable thing to do, but no doubt the production of such charts would call for very careful and painstaking work.

Mr. J. G. Clark (*communicated*).—I think the Society, as a body interested in general illumination problems, is under a debt of gratitude to Mr. Ritchie for his kindness in bringing forward the results of his painstaking investigation. Much of the data brought forward has been known for some time, but the author has put them in a new and lucid form, which makes them of great value. The facts given in the paper are no doubt indisputable so far as they go, seeing that every precaution seems to have been taken to ensure accuracy. The figures* given by Dr. Ives for the colour constitution of the light from various sources practically confirm Mr. Ritchie's observations.

While the facts in the paper may be indisputable, the inferences to be drawn from them are subjects for discussion. Colour, like illumination, is so much a physiological and psychological quantity that it is extremely difficult to set up anything like a standard.

If one glances briefly through the work of the Society, one outstanding feature will be noticed, viz., the realiza-

* *Electrician*, Feb. 4th, 1910.

tion of the importance of regarding the whole of a lighting installation as a single quantity, and to disregard the actual units themselves. This, of course, is logical, seeing that the usual object of light sources is to illuminate.

This point is important in regard to colour, because some 25 per cent to 50 per cent of the light that reaches, say, a table in a room, does so by reflection from the walls and ceiling, and if those surfaces have a selective absorption (as is nearly always the case) the colour composition of the light from the primary source will be altered. I notice in the case of the room in which Mr. Ritchie made his experiments that three of the four walls were lined with green-backed files. These would modify to some extent the colour of the light that fell upon the specimens of ribbon. Perhaps Mr. Ritchie can tell us to what extent the green surfaces would alter the results. It is, of course, conceivable that the modifying effect of coloured walls might correct the colour yielded by an incorrect source.

A practical difficulty is that of defining standard daylight. With the great variation in the colour and density of the atmosphere, and the variety of reflecting surfaces that abound, a daylight standard is, I fear, unlikely to prove of great value to us.

It is to be hoped that Mr. Ritchie's investigations will stimulate further inquiry into this important subject. The problem, to my mind, is not so much the production of a light equal in colour value to some predetermined standard, but to determine methods by which the colour composition of any light may be modified in any desired manner, as can be done by suitable absorption screens or reflectors.

A great essayist describes light as "the greatest of all painters," and I have noticed on more than one occasion that this idea has been put to practical use in America. By changing the absorption screens round the light sources the colour scheme of the interior architecture has been modified. It is, of course, important that the absorption screens should give harmonious effects in every case, and therein I think lies a field for future investigation.

In regard to the incandescent mantle used by Mr. Ritchie, What kind of burner was used? This point is rather important. I am inclined to think that the Ceria of the mantle acts in the main as a "black body," although no doubt it has a certain amount of selectivity. The Thoria, on account of its comparatively low emissivity, helps to boost up the temperature of the Ceria to a high value—higher, perhaps, than what we call flame temperature. The higher temperature would cause the point of maximum radiation to move towards the blue end of the spectrum, and it is probably a fact that the higher the temperature of the mantle the more nearly does the luminous emission approach the "daylight standard."

Different burners give flames of different temperatures. For instance, the intensified forms of gas lighting, both high and low pressure, have considerably higher working temperatures than ordinary burners. This results in higher luminous efficiencies, and, I believe, a light more nearly like the "daylight standard." I regret being unable at present to make any positive statement on this point, but I hope to investigate it shortly. It is interesting, however, to note that the layman's opinion of intensified gas lighting (high and low pressure) from a colour standpoint is very satisfactory.

Mr. J. S. Dow (*communicated*).—I should like to express my appreciation of the thorough manner in which Mr. Ritchie has carried out these investigations. At his suggestion I made a series of tests of the reflecting power of the ribbons by diffused daylight, and these were subsequently repeated by Mr. Ritchie. It was most striking to learn how closely the results he obtained approached those previously determined by me.

By the kindness of Mr. M. Foulds I was also afforded an opportunity of trying the Cooper-Hewitt lamp, and observing the effect of the Rhodamine reflector, kindly exhibited at this meeting. These results brought out very clearly

the improvement as regards red rays. The reflecting power of the dark red, which was 2·5 per cent by the mercury vapour lamp without the reflector, was increased to 5·5 per cent when the reflector was added. Similarly the reflecting power of the light red ribbon was increased from 3·7 to 10 per cent.

As regards the delicate shades of lavender, &c., it seemed rather hard to draw definite conclusions from these tests of reflecting power, in spite of the obvious improvements of colour in many cases. This leads me to ask Mr. Ritchie whether he thinks that this method gives satisfactory results when applied to discontinuous spectra. Possibly, however, the apparent discrepancies were due to the fact that the conditions did not enable me to take the fullest account of the shiney-ness of the material. Experience shows that the apparent reflecting power of a glossy ribbon (especially if highly coloured) depends on the direction of the rays striking it and the inclination from which it is viewed.

It may be of interest to mention that I have been making some experiments in conjunction with Mr. A. Cunnington, on a small apparatus for reproducing by mixture any desired colour. Perhaps this might be of additional service in studying such problems as those attacked by Mr. Ritchie in this paper. I am also disposed to acquiesce in Dr. Mees's contention that a complete spectrophotometer test, matching different illuminants throughout the spectrum colour by colour, is one of the best if not *the* best, and most accurate means of attacking these problems, when it can conveniently be applied.

Mr. John Darch (*communicated*).—I desire to add my expression of appreciation of the value of Mr. Ritchie's paper, and of the labour and care that he has put into it.

Yellow light is that which most concerns us. Sixty years ago M. Chevreul stated that

Yellow under yellow light became orange yellow (deeper yellow).

Orange under yellow light became yellower (orange yellow).

Yellow under orange light became yellow orange (orange yellow).

Orange under orange light became more vivid (deeper orange).

The words in brackets are variations on Chevreul made by Stickney and Church. Mr. Ritchie unfortunately lumps orange and yellow light together, and that light on a greenish yellow he finds to be "brightened many shades" (the specific hue presumably still remains); but yellow is "brighter and changed to orange," and orange yellow to "a deeper orange." Now all this does not accord with my own experience of many years with colours. I have found that a yellow light takes out the yellowness of yellow, and either whitens or browns it, while greens lose their brilliance and become bluer, or rather greyer. Looking round for some corroboration, I found in Church's book on 'Color,' p. 147, this remark: "pale yellow gloves under yellow illumination are hardly distinguishable from white gloves"—a fact which every draper knows. Any one can try this: take any dyed or pigment covered material of a fine yellow—gamboge or pale chrome—look at it steadily close to a candle, carbon glow lamp, gas, or oil flame in a darkened room or corner, and it will be found to be cream or pale buff; then suddenly bring it to strong daylight, and its specific yellow hue will reappear. In case this should be due to the mental effect of different contrasts, I arranged for a simultaneous comparison in a photometer box with daylight entering the aperture at one end and yellow the other, respectively illuminating each side of a V. The result was the same, but less striking; the yellow of daylight was the cream or buff of artificial light, and the orange a deeper buff. The explanation, no doubt, is that the wave-lengths of these lights are dominant red rather than yellow, and a poor red at that. M. Chevreul's yellow light must have been something different to that of our lamps to have produced the effects he describes.

The series of black, white, and intermediate shades which Mr. Ritchie gives to represent the "tone values" of various colours produced by different

lights can do no more than indicate their comparative luminosity. Would it not have made the matter clearer to have called them luminosity values, for although the word "tone" is correctly used to signify the brightness of a colour, it is so often confounded with ideas of hue, shade, tint, or the purity or dullness of a colour that its meaning may be a little ambiguous.

Mr. Ritchie, in reply, first referred to the point raised by Mr. Goodenough, and also he thought by Mr. Thornton, as to the possibility of the use with various illuminants of a filter so designed as to render the light from such equivalent to daylight, and said that he wished to emphasize the point that all his results had been obtained without the employment of any filter, and were results which could with equal ease be obtained by anybody at any time for the purpose of general illumination.

It was well known, he said, that a great deal had been done, and could be done, with suitable filters, but there were very many applications, in which an approximately colour-correct light was required, where the inefficiency of any type of filter prevented its use.

He would also like to state that he had been able to make some experiments with high-pressure gas, but as this portion of the work had had to be done elsewhere he had been unable to obtain sufficient uniformity in the actual working conditions to justify his incorporating the results in the paper. From what he had done he did not consider that the difference between high-pressure gas lighting and the inverted incandescent lights used in the tests referred to in the paper was as great as Mr. Goodenough appeared to suggest.

Mr Mackinney had raised the point that there was a certain section of the public who did not mind the expense, if only they could obtain the correct light. That was perfectly true, but there was a still larger section to whom efficiency was of very great importance, and who were exceedingly desirous of getting not only a correct light, but also an economical one, and if they could be given a system of lighting which was practically the one and assuredly the other, then he thought that that was something to the good. He was glad to have Mr. Mackinney's statement as to the purity of the glass from which the Holophane glassware was manufactured, and his assurance that such glassware did not in itself alter the colour or character of the light produced by the illuminant.

Mr. Mackinney had also touched upon the question of photography. They all knew the importance which he (the speaker) attached to that in the work in which many of them were engaged. He thought that the Illuminating Engineering Society had during the past two years raised the standard of artificial light photography very considerably, and if any work of his was thought to have contributed to that end he was more than repaid for the trouble he had taken.

Dr. Mees had, in his criticism, mentioned the difficulty of correctly rendering the greens. This was a very real difficulty, and it was precisely for that reason that he, in reading the paper, specially emphasized the point that the photographic results must be taken in conjunction with the visual observations. Neither should be taken alone. On the one hand there was the insensibility of the eye, or the liability of the eye to error, and on the other the inherent defects of the photographic process, and he thought that if they took, as he had taken, something approaching a mean between the two processes this would tend to, as far as possible, eliminate the errors (which, after all, as Dr. Mees had said, were exceedingly small), and they would arrive at results which might be taken as correct.

Mr. Trotter had suggested that the paper told them most about the representation of tone values by photography, and that although "it purported to deal with colour discrimination," it really had dealt chiefly with colour photography.

This was, he thought, incorrect. Tone values had been dealt with photographically, and colour values—or, in other words, colour discrimination—

had been dealt with visually in (with the exception of any possible difference between the two pairs of eyes), exactly the same manner which Mr. Trotter appeared to have adopted. He regretted Mr. Trotter's difficulty as regards the colours of the ribbons used. They were, as he had stated, exhibited for inspection, and had been before the meeting throughout the evening.

Mr. Trotter had also objected to the designation of the colour described as "emerald green," as well as to the notation adopted in connexion with the tintometer. This subject was full of difficulties, and he could only suggest that those who wished to realize what the difficulties were should embark upon some experiments of the kind. They would be sadder and wiser men before they were very much older. He (the speaker) had anticipated that exception would probably be taken to *any* description of the various colours which could possibly be used and had therefore taken the precaution of, as stated in the paper, having such named by Mr. Lowdan, whose experience with colours had been very great, and who could probably be trusted to describe them very much more correctly than either Mr. Trotter or himself.

It was, he had found, useless expressing a colour to the average individual in a highly scientific manner, but if one could give him something which, whilst it had a scientific value, which in his opinion was very great, was also a simple, usable, appliance by which a definite match could be repeated at any time, then the difficulty disappeared.

That was his point. He did not want merely to call a colour a "deep red," and he therefore gave its composition according to the tintometer notation, because there was no question but that, with that instrument, it was possible to readily reproduce the particular shade at any time.

Moreover, he failed to see that the notation adopted by Mr. Lovibond in connexion with his tintometer was in any way more arbitrary than that adopted by Mr. Trotter in describing the cobalt blue glasses used in his experiments. He had also used, as Mr. Trotter had, a series of water-colour tints provided by Messrs. Windsor and Newton.

Mr. Lovibond had raised several rather interesting points, upon some of which he (the speaker) would have liked to dwell, and had asked as to the method adopted in the calculation of the candle-power of the illumination and as to the angle of incidence. He was in complete agreement with much of what Mr. Lovibond had said, but as time pressed, would only state in reply to his queries that he had not attempted, in these tests, to measure the different lights from the physiological standpoint, but had, as stated in the paper, in each case determined the illumination upon the ribbons by actually measuring it with the lumeter photometer in international foot-candles and without regard to the colour of the light. The angle of incidence of the major portion of the light rays falling upon the objects was, as far as could be ensured, the same in the case of each of the illuminants with the possible exception of the "0·1." inverted arc lamp in which the light was, as was inevitable, considerably more diffused.

He was particularly glad to note Mr. Lovibond's agreement with him as to bright diffused daylight being decidedly the best standard for use in dealing with questions involving colour changes and discrimination.

Dr. Edridge-Green had raised the question of the difficulty of a daylight standard; this was, of course, a difficulty which was inherent. We could not, he said, get our daylight made to order, and in London particularly, a standard was a most difficult thing to obtain.

If the Illuminating Engineering Society would take upon itself to determine a standard of daylight, it would accomplish something of much greater value than even the very many valuable things which it had already successfully achieved. In adopting bright diffused daylight at midday in early September, and in this way securing a mean between summer and winter, he thought

he had obtained as true an average as could readily be determined.

As regards discrimination of colour, his own eye value (right eye) by Dr. Green's Colour Perception Spectrometer was 24, which was distinctly above the average, although not as high as figures which he understood had been recorded.

Mr. Harrison had expressed the opinion that the tests were a measure of the actinic qualities of the various lights. This was a point upon which he had already touched. The tests had, as had been explained, been taken both photographically and visually, and it was therefore incorrect to summarize the results as actinic values, or as visual values. They were, as far as they could be made, a mean between the two.

Mr. Harrison had also accused him of desiring to do away with colour discrimination—or lack of colour discrimination—he was not quite clear from his remark which was really intended—had censured him for not explaining the "peculiar chain of physiological and psychological events" which he had expressly stated at the outset were incapable of explanation, and had expressed the hope that the light he was seeking might never materialize. He did *not* desire to do away with colour discrimination, but rather to supply light users with an illuminant which would materially increase it. He made no claim to be able to explain the unexplainable, and, although of a very optimistic nature, could assure them that he was not sufficiently optimistic to imagine that they would arrive at the perfect light this week or next.

Then Mr. Harrison spoke of the lady who, "if she had any sense," would purchase her dresses by a light similar to that by which she intended to wear them. He thought this would work out most peculiarly in practice. He was favoured to the extent of knowing many ladies, but he did not know any who had yet adopted the system of labelling their garments "gas light," "arc light," "metal filament lamps," "tallow candles," and so on, and he thought that it would be a long time before that nomenclature, which would be even more extraordinary than Mr. Trotter apparently considered Mr. Lovibond's, came into general use.

Mr. Harrison had also raised the point that they should have special pictures painted by the artificial light by which they would be viewed. Did he, then, consider that the contents of our National Galleries—our Rubens', our Velasquez', and our Turners—should be repainted? as, without this, most of them could never, in this country, be shown by the light by which they had been produced. It was quite true that they could have such pictures as Mr. Harrison had suggested, but how peculiar they would look during the day time, most people's dining-rooms being used, he presumed, for breakfast and lunch, as well as for dinner and supper.

They might also have—to carry the idea to its logical conclusion—special wall-papers, special carpets, &c., and, generally, very special homes to live in; but he did not think that this suggestion was really feasible, or could be treated seriously. It was surely better to aim at what was correct for daylight, and then arrange for the artificial light used to approach such daylight as nearly as might be, not only as regards its colour, but also to some extent as regards its intensity, and to better it—as they easily could better it—as regards its constancy.

Mr. Gaster's remarks had been interesting, and, as was usual, very much to the point. There were, as he had stated, some colours which could neither be produced nor worked with by *ordinary* artificial light. Any lithographic printer would, for instance, bear out this statement. It was also, as he had said, "very important to know what illuminant best approached daylight," and that was exactly what he had tried, he hoped not altogether unsuccessfully, to demonstrate to them.

He was afraid that he could not promise to undertake the preparation of the colour charts for which Mr. Gaster had asked, but hoped that, for his sake, some other member of the

Society would prove more venturesome, in which case he would be pleased to render what help he could.

The points raised by Mr. Clark were of interest. He thought, however, that in suggesting that the whole of a lighting installation should be regarded as a single quantity, without regard to the actual light units—or, he presumed, the colour or character of the light emitted by them—Mr. Clark had in mind rather that class of lighting in which the colour of, or the colour effects produced by, the light, however incorrect such might be, were of secondary importance, rather than those cases in which colour-correctness was essential. In such cases one should not only ensure the correctness of the initial light, but also, as far as practicable, prevent its being disturbed by reflected light. In cases of fine matching the whole of the interior of the matching chamber had, as a precautionary measure, usually a matt black surface, although he thought that such was rarely necessary other than in extreme cases.

In his own tests he had tried lining the walls with white paper, but as he had not been able to obtain, by so doing, any different results, and as access to the files was of importance, he had dispensed with it.

He did not agree with Mr. Clark either as to the difficulty of defining a standard diffused daylight, or its lack of value when defined. Daylight, whilst varying considerably in intensity, did not, as Dr. Mees had pointed out, and as many artists had known for a long time, alter materially in colour.

The burners used in the obtaining of the photographs taken by inverted incandescent gas light were of the regenerative or intensified type, of a make which, he understood, was approved by the leading gas companies.

He much regretted the time had prevented Mr. Dow's exhibiting the apparatus used for the reproducing of colours by mixture, which, he thought, would have been of considerable interest to those present.

He was glad to have the results of the tests made by Mr. Dow with the mercury vapour lamp, without, and with, the Rhodamire reflector. There was no doubt that the latter improved matters very considerably by supplying a certain proportion of red rays, but he felt some doubt as to its permanency.

As regards Mr. Dow's query as to the character of the results obtained by a comparison of the percentage of light reflected by a given fabric under different illuminants when applied to discontinuous spectra, he should be inclined to question the accuracy of the results obtained, although as he had not had much experience with the mercury vapour light, he was not prepared to say that such results would of necessity be incorrect. As regards the method generally, he thought that it was capable of giving exceedingly accurate results if care was taken to keep the direction of the light rays falling upon the surface to be examined constant, and to keep the photometer always at right angles to such surface.

He quite agreed with Mr. Dow as to the advantage of comparing the different illuminants by matching them, colour by colour, throughout the spectrum by a complete spectrophotometer test. Such a method was the only way in which a really reliable filter screen could be evolved; but Mr. Dow had apparently overlooked the fact that a test of this nature would fail to afford any information as to the effect of any particular light upon any particular coloured object.

It was unfortunate that Mr. Darch was not able to raise his point anent the yellow and orange ribbons during the meeting, as he would then have been able to have satisfied himself by an examination of the appliance exhibited by Mr. Mackinney. The point was involved by reason of the fact that neither the yellow nor the orange used were by any means true colours; that both were very sensitive to any alteration in the percentage of red rays; and that the yellow lights, so called, were also in reality anything but pure yellow. The results were carefully recorded, as observed, without reference to the authorities he had quoted, and if, as he stated, they agreed therewith, it hardly seemed likely that all would have fallen into error.

DISCUSSION

OF

Some Aspects of Railway Station and Goods Yard Illumination.

BY HAYDN T. HARRISON, M.I.E.E.

(Paper read at a meeting of the Illuminating Engineering Society held in the House of the Royal Society of Arts (John Street, Adelphi, London), on Tuesday, December 19th, 1911.)

(*Continued from p. 42*).

MR. ROGER SMITH, in starting the discussion, wished to remind the meeting that the business of a railway company was to sell what the Americans called "transportation." In all railway lighting this had an effect upon the choice of illuminant, which might depend more upon general policy than on the actual question of which was the best illuminant to employ in any individual case. Supposing, for instance, that for a particular railway station the price of gas was 5*s.* 6*d.* per 1,000 cubic feet while electricity cost ½*d.* per K.W.H. It would appear as if electricity should be the illuminant, but it did not follow. The carriage of the whole of the coal used by the gas company of a town may depend upon using gas for its railway station. The value of this freight would far outweigh the small saving to be gained by the use of electric light. Again, it may be right in a small generating station belonging to a railway company deliberately to increase the cost of coal from, say, 3*d.* to 4*d.* per unit, in order to use coal which passed entirely over the railway company's system, rather than pay freight to another company for cheaper coal. Should electricity be dearer than gas it might, for other reasons, still be used for lighting. One such case would be where a large goods shed and yard was provided with electrical machinery, the supply for which reduced the cost per unit (whether the electricity was made by the railway or bought), while the necessary existence of electric distributing cables for power made it particularly cheap to instal electric light.

Again, the use of electricity for both lighting and power might be right, because by so doing the cost for power was decreased, although for lighting alone gas might be the cheaper. These instances were mentioned to show that for railway lighting the choice of illuminant had always to be considered in relation to general policy, and this withdrew railway engineers somewhat from the keen competition between illuminants, but made their comparison on the basis of measurement still most important. How difficult it was to compare the cost of two illuminants on the basis of minimum and maximum illumination only those who had endeavoured to do so really knew, but it was the only commercial basis on which a comparison could be made. He was a little embarrassed by what the author had said as to the speaker's standard of minimum illumination for railway station platforms, because the author, though quoting him absolutely word for word, had quoted the text without the context. The minimum of 0·25 foot-candles recommended for railway platform lighting, mentioned in a paper on Electric Train Lighting, was only intended to apply to large termini where trains would be standing for a considerable time, and where it seemed to the speaker important that there should be a definite relation between the maximum illumination on the platform and the illumination inside electrically lit coaches. He quite believed that for the platforms of terminal stations the illumination on a horizontal plane three or four feet from the ground need not exceed two foot-candles as a maximum, and should not be less than 0·25 foot-candles as a minimum, giving a diversity factor of 8, but he never intended to suggest that such a high standard of illumination should apply

to all the stations of a large main line railway. He was very glad, however, that this question of the proper minimum illumination for platform lighting had been taken up, and suggested tentatively that for intermediate important stations and large junctions a minimum of 0·15 foot-candles was adequate, but that at small wayside stations only "Beacon" lighting, as Mr. Trotter had called it, was required. When a train was at the platform the carriage lighting gave quite a reasonable illumination, and spots of light were at other times quite sufficient, as had been pointed out by Mr. Henry Fowler in his excellent paper referred to by the author. He did not pretend that this was a high ideal, but it must be remembered that, owing to the demands of the public, railway expenses were constantly going up without any increase in rates or fares, and some of the figures given in Mr. Harrison's paper really could not be afforded on the platforms of non-terminal stations with trains every hour or so.

Among the important points brought forward by Mr. Harrison, one of the most interesting was the employment of small units of light. The use of small units and the possible resulting economy were important; and especially so in gas lighting, where the provision of a compressor for high pressure gas and the necessary attendance might not be economical for a comparatively small number of lights. It must not, however, be forgotten that with small units placed low down the elimination of glare became difficult on account of the lamps being nearer to the line of sight, while the spacing of the lamps must conform to the bays of the roof, otherwise the daylight appearance was bad.

In Mr. Harrison's table No. 3 some of the minima mentioned filled him with alarm. A minimum of two foot-candles, except where required for lighting advertisements, appeared to him a quite unnecessary extravagance in railway platform lighting, and for this reason he thought that the last column in Table 3 (watts per foot-candle per 1,000 feet) was not the right standard of comparison, unless all the lighting compared had one definite minimum illumination. Column 2 (watts per 1,000 feet of platform) represented what the railway company had to pay for, and provided the minimum illumination reached a definite standard, this column really represented the commercial value of the lighting. There was one point which Mr. Harrison had not touched upon, and that was the illumination of the roof of a station. There were a good many railway stations in this country with no illumination above the level of the lamps themselves. To his mind, to look up into a black space above the lamps was most depressing, and he was sure that it was worth while to spare a small percentage of light to go straight up from the lamps to illuminate the roof. The cheerfulness of a brightly lit ceiling in a room was well known, and quite a moderate amount of light in a station roof produced a sense of warmth which was very grateful and had a certain moral effect. A good deal of excellent platform lighting in stations where roofs were high was at present marred by the blackness above the source of light.

The author had made more than one kindly reference to himself, for which he was very grateful. At the same time, he was disposed to doubt if his collaboration with Mr. Harrison, which had been at first suggested, would have added greatly to the interest of the paper, though he would gladly have shared the credit for it with the author.

Mr. Frank Bailey (Engineer to the City of London Electric Lighting Co.), said he represented the Telegraph Construction Maintenance Co., for the original lighting of the G.W.R., from Westbourne Park to Paddington about 1885 when the chairman of the contracting company was also chairman of the railway company. Being anxious to satisfy both parties, he certainly did put in plenty of light, and in spite of the most glorious illumination there were never any complaints that there was too much light. After that installation was put in, the hand lamps which had hitherto been carried by every man of importance on the station were done away

with. He thought it was a pity to pin their faith to one definite minimum or maximum standard of illumination considering there was such a very large scope. At the same time, he thought they should never get below 0·25 foot-candles, which was imperative in all cases. He advocated the use of lamps high up under the roofs of stations not only because it attracted traffic, but also because it compelled the railway company to keep their roofs cleaner. This method of lighting, of course, could be supplemented by lamps at a lower level, so that ticket inspectors and porters could go about their work in comfort. There were very good reasons why the whole subject should receive careful attention on the part of railway companies and their engineers, and he hoped the latter would take it up as part of their normal work, and not regard it as a subject below their attention. They should rather regard it as their special province to improve the illumination. Certainly there was very much room for improvement, not only in the country but even in London.

MR. BURGESS (Midland Railway Co.) said there seemed to be many ideas as to where the illumination should be measured. One person measured at a height of 4 feet above the platform, another at 3 feet, and another at 40 inches, whilst another took measurements along the edge of the platform. It would be a considerable help to arrive at a comparison more quickly if a standard height were adopted, although it did not alter the facts in the case.

The standard of illumination given by Mr. Roger Smith, he thought, was one which might be adopted at the larger stations. On the previous evening he had taken readings at a station which had been recently fitted with high pressure gas and inverted mantles. The lamps are 16 ft. 6 inches high, and 73 feet apart. The maximum illumination was 2·75 foot candles, and the minimum 0·4, and these approached very nearly what Mr. Smith suggested. There seemed to be almost a contradiction in the paper, because the author advocated the use of low candle-power lamps at a moderate height, and then mentioned high candle-power lamps placed about 50 feet high in the Goods Yards. On the different railways, of course, the method of working varies, but on the railway with which he is connected it is considered more advantageous to have comparatively speaking, low candle-power lights at about 12 to 15 feet above the ground.

He had in mind an example of a shunting yard with a siding which opened out into about fourteen lines, where it was necessary to provide a good light in order that the shunters could see that the waggons were clear of the siding, and also that the particular row into which the waggon was to enter was clear. It was found to be a great advantage to fix a row of lamps of 150 c.-p. and with convex reflectors across the point midway between the siding and the lines on to which the siding opened. This served the double purpose very well.

MR. HERBERT JONES dealt with the subject from the point of view of the electrical engineer, and drew attention to the great improvement possible at railway stations, both in illumination and consumption of electricity. He considered the author's quotation from Mr. Roger Smith's paper on 'Train Lighting' somewhat misleading owing to the omission of a portion of the paragraph; the point was that the maximum illumination on the platform should never exceed the minimum illumination on the train, otherwise the compartments would appear poorly lit, and it was partly for this reason that 2·5 foot-candles was decided upon for first-class, and 2 foot-candles for third-class compartments. In the speaker's opinion they should take 1·5 foot-candles as the minimum on the train, and should aim at 0·33 foot-candles as a minimum, and 1·33 foot-candles as a maximum, on the platforms of important stations.

He preferred the term *illumination ratio* to *diversity factor*, which was already in use for another purpose, and recognized the difficulty in obtaining the 4 to 1 illumination ratio necessary to arrive at the above values.

From the point of view of illumina tion he divided railway stations into three classes :—

Firstly, terminal stations usually completely roofed over with high roofs ; here flame arc lamps with dioptric globes placed 30 to 35 feet high and about 150 feet apart would usually give the best results.

Secondly, important junctions usually have a low roof over the platforms only, where tungsten lamps with "Holophane" or other suitable reflectors could usually be arranged to give a 2 to 1 illumination ratio on the platforms. With platforms of the average width an illumination between the limits of 0·33 and 0·66 foot candle could be obtained with a consumption of 3 to 3½ watts per foot length of platform.

Thirdly, less important and wayside stations. Here he agreed with a previous speaker that only "spot" lighting was required, but would add that a low value illumination was desirable for the covered portions of the platforms.

In all cases local illumination should be provided at the barriers for the inspection of tickets. It was easier to obtain a low illumination ratio with tungsten lamps and suitable reflectors than with flame arcs, but the latter were, in his opinion, more economical for stations with high roofs, and being placed high up illuminated the roof to a certain extent and so avoided the gloomy appearance a station presents when the roof is left in darkness.

Apart from the inconsistency of measuring illumination in foot-candles and taking the metre for the standard height of working plane he considered the true working plane in this case was lower, and preferred to consider the platform level as the working plane.

Referring to Table 3 in the paper he noticed that the watts per foot-candle per 1000 feet given in the last column were based on the minimum illumination and not on the average, this implied that the author considered that any illumination obtained in excess of the minimum was waste ; he could not agree and preferred to work out results in watts per average foot-candle and to state the illumination ratio.

In Table 2 the figures given for total candle-power per 1,000 feet were based on the candle-power of the lamps at the angles stated in the fourth column, and as this entirely depended upon the employment of suitable reflectors he considered the result most misleading.

As an example of the results obtainable by the employment of suitable reflectors the speaker mentioned that the booking hall at Waterloo Station (L. & S.W.R.) is lighted with 8 200-watt Osram lamps in "Holophane" reflectors spaced at practically a uniform distance apart and 21 feet high; the hall had a floor space of 3,200 square feet, and a consumption of only 0·5 watt per square foot gave a practically uniform illumination of 1·5 foot-candles, equivalent to 3 foot-candles per watt per square foot. In shed lighting he had experimented with enclosed flame arc lamps and obtained an average illumination of about 0·8 foot-candles with a consumption of only 0·1 watt per square foot, but owing to the lowness of the shed roof the illumination ratio was 1 to 20, and there was considerable flicker and change in the colour of the light. The maximum candle power of the lamps was given at an angle of only 15 degrees below the horizontal and consequently there was a certain amount of glare.

Mr. A. P. Trotter spoke on the question of distribution of light. With regard to tube station platforms, these were obviously excellently lighted, but a certain amount of the light was wasted on the track, which was unnecessary. For this class of lighting Mr. Harrison's suggestion of small lamps placed fairly low down, and plenty of them, would be the most economical. On the other hand, if they departed from this it seemed better to put the lamps quite high up and try to illuminate the whole of the station with one set of lamps. If there were two trains standing side by side, and the lamps were at all low, shadows would be cast over the platforms, and in these circumstances it would be better to have separate lamps for lighting each platform.

Mr. Harrison had stated that the lighting of goods yards was a similar

proposition to station lighting. Mr. Harrison and himself had often crossed swords over the question of illumination on the horizontal plane or the vertical plane. He (Mr. Trotter), had always maintained that for street lighting and general purposes, if the illumination received on the horizontal plane was good all the rest of the illumination would be better; he was therefore surprised to hear Mr. Harrison say that for goods and shunting yards illumination on the the vertical plane was of importance on account of the way-bills, labels, &c., to be read. Yet the railway people always seemed to put lamps in their goods yards very high. At Nine Elms yard, where he believed electric arc lamps were first used for such work, they were very high; at Tilbury Docks and elsewhere lamps were also quite high. This seemed common practice, and yet the lighting required was mainly, he should have thought, for the sides of the trucks.

Where, however, they wished to inspect a time table, for instance, illumination on the horizontal plane was no good at all, and it was evident that in railway stations, besides general lighting, special lighting was required for such purposes as time tables and booking offices.

Mr. E. P. Grove (Central London Railway) said that as far as his company was concerned changes were made not on account of the unsatisfactory nature of the lighting, but rather with the idea of economising in cost.

Experiments commenced at the Marble Arch Station with opal shades, using 1,000 watt Tungsten lamps in place of the arc lamps. Immediately complaints came in from the Traffic Department inquiring whether it was intended to put the station into darkness. In consequence 200 watt lamps were substituted for the 100 watt lamps, but under these conditions there was very little saving unless an exceptionally long life was obtained from the lamps, They next changed over to Holophane bowl lighting and small Holophane tulip shades, using first 10 and then 15 lamps per platform. Different candle-powers and different types of Holophane reflectors were used but there was still not enough illumination. The final result of these experiments was the adoption of 15-100 watt lamps which gave the satisfactory result referred to by Mr. Dow at the British Museum Station. That was about as good illumination as could be wished for, but even that was not considered "bright" enough by the Traffic Department, who considered it did not come up to the arc lighting. Personally, he thought arc lighting had a little more cheerful aspect, but Holophane reflectors, he considered, were going to make a good deal of improvement in lighting because they allowed of light being reflected in certain directions where most desired.

It might be taken that the Central London Co., had adopted the Holophane system with Tungsten lamps as their standard for platform lighting, and were dealing with all their stations in this way. With regard to the lighting at British Museum Station, it might also be mentioned that the original arc lighting consumed 3,000 watts, and the present Tungsten lighting consumed about 1,300 watts, so that there was some saving, in addition to the very satisfactory nature of the light. The life of the lamps was usually about 1,500 hours. Previous speakers referring to tube railways had, he thought, overlooked the fact that advertisements were a very important item from a revenue point of view, and they must be well lit. This accounted for a good deal of the light being low down near the train. He looked at the ilumination from the point of view that it was necessary that a man standing on the platform should be able to read his newspaper. From this standpoint he was not sure that 4 ft. or 40 in. from the platform was quite a suitable standard at which the illumination should be measured.

With regard to the surface stations, he did not know if any of those present at the meeting had noticed what had been done outside Oxford Circus station. The original enclosed arc lamps had there been replaced by enclosed flame arc lamps, not from the point of view of illumination in the ordinary

sense, but with a view to making the place more cheerful and more attractive to the public, as traffic had to be prevented from going elsewhere. His company had only that afternoon decided to extend the system of flame arc lighting outside their stations. In the booking halls Tungsten clusters were being added in some cases to provide for the illumination of certain points when the arc lamps were off.

In connexion with the advertising illumination the mercury vapour lamp came in very useful, as the long tube lent itself well for glass signs where good diffusion over large surfaces was desirable. In this connexion he would like to call attention to the large sign erected over the Shepherd's Bush station, the canopy over the entrance to Bond Street station, &c. Practically the whole of the lighting was done at 550 volts from separate lighting feeders from the sub-station, which necessitated lamps being run in series. He thought the tendency would be for a minimum illumination of at least 0·25 foot-candle, not from the point of view of accidents, but because people were demanding more light.

[In connexion with the author's remarks at the close of the discussion, Mr. Grove would like to add that he is at a loss to understand the author's inability to find the station which the company had illuminated in the manner referred to, inasmuch as Oxford Circus, Tottenham Court Road, and Bond Street stations were completed before the end of September last, and British Museum was the last station lighting to be put into commission, and half of the stations were now changed over to the new system.

He would also like to take this opportunity of stating that he had nothing but high praise for the Westminster arc lamps, which were in as good condition as ever, the change merely being made on the score of economy.]

Mr. John Severs (Great Northern & City Railway Co.) said that his company had proceeded more or less on the lines mentioned by Mr. Grove, namely, by taking out the enclosed arc lamps and putting in lower candle-power tungsten lamps. They started with ordinary opal shades about 8 ft. 6 in. from the platform, but that was not good enough for the traffic. Then they put in hemispherical "Holophane" shades and took away the shades over the top of the lamps, in this way doing what Mr. Harrison suggested, namely, making full use of the reflection from the white tiles. As was shown in the photograph described by Mr. Dow of the Old Street Station, there was a very good distribution of light all along the platform. In the passages also they had taken away the opal shades over the tops of the lamps, and in this way got a much better distribution of light. The tunnels on the Great Northern and City were 23 feet in diameter, and the platform was about 3 feet below the centre line, and with tungsten lamps about 28 feet apart in hemispherical globes about 3 or 4 feet from the white tiles of the roof, there was a very good distribution of light, which entirely satisfied the traffic department.

The same standard of lighting cannot be taken for low level tube stations as for open stations. On a bright summer's day a passenger entering a tube station which is actually very well lighted will be under the impression that the light is poor, due to the comparison between brilliant daylight and artificial light. The passenger entering the same station at night finds the same lighting quite brilliant; so necessarily tube passages and stairs leading to the platforms at times appear to be over well-lighted.

Mr. J. G. Clark (Gas Light and Coke Co.) referred to some experiments carried out by Mr. Dow and himself at Victoria Station L.B. & S.C. Railway upon Keith inverted high-pressure gas lamps. It so happened that two or three years ago he made some observations at the same station, when it was lighted by upright burners working at the same pressure as the present inverted burners. It was interesting to notice that in both cases the maximum and minimum illumination were practically the same, but there was a great saving in gas with the inverted system. This saving was of the order

of 40 or 50 per cent; *i.e.*, the illumination on the platform was identical with 40 or 50 per cent less gas. He also referred to the point as to whether the minimum illumination on the platform should be higher or lower than the illumination in the carriage. He understood that Mr. Smith's limiting maximum of 2 foot-candles was based on this consideration, the carriage, presumably, having an illumination higher than this. Mr. Clark thought it might be an advantage if the platform was more highly illuminated than the carriage, so that a passenger stepping from a carriage would not feel the temporary gloom which would result if the platform were less illuminated.

Platforms are often full of obstacles of various kinds, and these would be more easily avoided if the platform were brighter than the carriage.

The Chairman, before calling upon Mr. Harrison to reply, mentioned one or two points. He quite agreed that small units were as a rule advantageous, provided they were reasonably close together. The minimum of 0·25 foot-candle was one that all suppliers of light would like to see adopted for all stations. It was probably considerably too high for out-of-the-way country stations, and it was certainly considerably above the illumination that was found at country stations, some of which were lighted in the most dismal fashion, especially after the light given by a train standing in the station was withdrawn by its departure.

He thought Mr. Harrison had done a good service to the travelling public in calling attention to this subject, and it was also a matter of satisfaction to know that railway engineers generally were paying very much more attention to illumination as a science than they used to. Good lighting was as economical in railway station work as in many other cases. It enabled the work to be done more quickly, and there was less waste if there was a good light for everybody to work by. It was also, as Mr. Grove had pointed out, a good advertisement.

Mr. J. R. Fletcher (*communicated*). In thanking Mr. Haydn Harrison for the exceedingly interesting paper on 'Some Aspects of Railway Station and Goods Yard Illumination,' I should like to inquire at what efficiency the tungsten lamps have been calculated when making comparisons with various types of arc lamps?

It is a question of some importance as I believe the comparisons have been made assuming an efficiency on tungsten lamps of about 1·35 watts per British candle-power, and as regards the higher candle-power tungsten lamps certainly from 200 watt size and upwards, a very reasonable life probably averaging over 1,500 hours could be attained when the lamps are worked at an efficiency of 1·1 to 2·2 watts per British candle-power, whilst I think the tendency will be in the future to adopt even higher efficiencies still, which would make the argument in favour of the adoption of tungsten lamps against arc lamps still more favourable than it is at present.

Railway engineers on account of the extraordinarily low price at which they can generate current, probably in many cases down to ·5 of a penny per B. O. T. unit, are inclined to run tungsten lamps at an efficiency lower than the normal so as to obtain abnormal life with the lamps, and as Mr. Harrison's comparisons do not take into consideration the initial cost of arc and tungsten lamps the fact of rating the tungsten lamps at lower than the normal efficiency acts rather unfavourably to the tungsten lamp when current consumption in watts per candle-power is considered apart from cost of installing.

Mr. Harrison touched on a further interesting point, *viz.* the *reduction in illumination when the platforms are not in use*, and it was suggested that one high and one low candle-power lamp should be installed per point, the high candle-power only to be used when the trains are standing at the platforms, but I think the more economical plan and certainly one that would considerably reduce the cost of wiring, would be to make a three-terminal lamp with filaments in two groups in parallel, so that the low candle-power filament can remain permanently alight, and

the high candle-power filament be switched in as the train approaches.

I do not think there is any great manufacturing difficulty in the way, and intend making up some experimental lamps on which tests can be carried out.

MR. C. R. WILLIAMS, G.W. Railway (*communicated*).—On the Great Western I am confident that there is no station or depôt of any importance lit by gas, which has the same low standard of illumination that existed ten or twenty years back, incandescent lighting being installed at over 600 stations, depôts, and receiving offices. The change from flat-flame burners has cost nothing, the savings having wiped out the expense, and large permanent savings effected; further savings are now being attained by the gradual change from upright to inverted lighting.

Standardization of lighting for long narrow platforms, with columns of varied spacing, supporting low verandah roofs, was difficult. Existing supplies and fittings had to be used to the utmost, including, in many cases, the old-fashioned lamps being in good state of repair. It was necessary also to adopt standard patterns of mantles, glasses, &c., for economical renewals.

The minimum illumination of such stations on the Great Western varies from 0·14 foot-candles to 0·03 foot-candles, while the diversity factor ranges from 7 to 30. The upright burners give better curves, but the inverted show greater economy in gas consumption and mantle renewals.

Frequent attempts have been made to obtain better curves, but spacing of lamps, irrespective of the position of columns, proved unsatisfactory and unsightly; moreover, shadows were irregular and most marked.

As regards height of lamps, the space is confined, and we found by trial that the cost of a slight raising of lamps would be disproportionate to the infinitesimal increase in the minimum illumination traceable only by photometer, and unrecognized by the travelling public or the operating departments of the railway.

We have throughout recognized the assistance of the train-lighting, which probably doubles the minimum on the platform just when required, *i.e.*, when a train is standing at the station and work is being done. At other times even the ordinary light is considered wasteful, and all lights are lowered by distance control for each platform.

This is particularly noticeable at country stations—of which we have over 500—where oil lamps, often spaced far apart, afford the "illumination." In these circumstances hand-lamps are used, and the train lighting does the rest, between trains the stations are in comparative darkness.

With regard to the suggestion originally put forward by Mr. Roger Smith that terminal stations should have a minimum not exceeding 0·25 foot-candles, with a diversity factor of 10. I think this is good lighting for the purpose, and the range of 10 is a happy medium between wasteful lighting and a "patchy" effect. I see no necessity in illuminating the high roofs. Two good instances of lighting which approximate this ideal are Paddington, with flame-arc lighting, and Victoria, L. B. and S. C. Railway, where I have had readings taken on No. 9 platform. For verandah-covered stations I think 0·05 foot-candles sufficient.

As regards units of light, I advocate the smallest obtainable, with due regard to maintenance expenses, cleaning, renewing mantles, &c. Even in large termini, lamps should be reasonably small, and as closely spaced as the roof-girders will admit—say about 50 ft. apart—and at the requisite height to obtain the 10 to 1 variation. The authors' suggestion of lighting the columns of country stations might not be a success, owing to vibration. We find the hanging lamp, with ball point, satisfactory for mantle renewals, and we generally avoid rigidity.

Our present standard methods are to provide small inverted burners, singly or in clusters, varying from 2 to 6 burners, with superheated chambers; by this we obtain a "duty" varying from 25 to 35 candles per cubic foot of gas, glasses are now

dispensed with, and the life of mantles is good.

This also applies to the lighting of goods sheds and yards—a fair example of the former is the Smithfield Goods Depôt of the Great Western (situate underneath the Central Meat Markets of the City of London, and connected by rail with the Metropolitan Railway). The roof consists of girders and brick arches, the depôt being divided into three parallel areas of cartway, deck, and sidings, of which the minimum lighting is as follows :—

Cartway and Deck	0·6	foot-candles.
Turntables	0·7	" "
Capstans	0·3	" "
Points at outlet from sidings	0·7	" "

This illumination is provided by high-pressure inverted burners in plain lamps suspended from the girders, all parts being easily and cheaply renewable.

For yard lighting I have adhered, with only a few exceptions, to a system of lighting the "danger zone" near points and crossings, *i.e.*, the clearance between converging lines, by means of yard lamps with burners not more than 16 ft. above ground, and not exceeding 200 candle-power.

This method is less likely to be interfered with by shadows than large units on high masts, and many years' experience and approval of the shunters confirm this.

With regard to the most interesting results given by Mr. Dow, I venture to say that there is no comparison between the lighting requirements of tube or underground stations in London or other large cities, and that of country stations, and to increase our present illumination would mean many thousands of pounds in extra annual cost. Our present lighting meets with the approval of those who have to work the stations—or we should soon hear something about it.

MR. JUSTUS ECK (*communicated*): Mr. Haydn Harrison's paper is a timely one, the improved lighting of railway stations, especially urban and suburban ones, where the density both of passenger and goods traffic is increasing by leaps and bounds needs urgent consideration. Most of the termini in London and the great cities of the United Kingdom require setting in order in this respect and it is to be hoped that railway engineers responsible for the work will make their requirements more definite so that specialists may produce, should it not exist, the class of lamp suited to their needs.

There is no question that a railway station should appear as well lit by night as by day, and this should be secured without interference with the technical working, by this is meant—the roofs, walls, platforms, permanent way and outsides of rolling stock should be well lighted, shadows should be foreshortened, and no lights should interfere with observation of signals whether of the semaphores, guards, or shunters. Lamps placed as low as 13 ft. above platform level are bound to interfere with the observation of signals, will inevitably produce glare effects in the eyes of passengers and must render time tables, notices on coaches, &c. difficult to read, and will throw the tracks into deep shadow.

The figures given as to the efficiency of flame arc lamps are evidently in error unless some obsolete type with vertial carbons or without economiser, or possibly with low grade or enclosed carbons has been taken, while it is well to remember that refracting globes are more common with "deposit free" flame arc lamps than the "suitable reflector" is with tungsten lamps.

Possibly the same pattern of lamp has led to the further erroneous conclusion that the cost of maintenance of flame lamps whether based on measured platform illumination, or on measured emitted candle-power is greater than with any system of metal filament lamp lighting.

The efficiency of gas and electric lighting have increased so greatly in the last few years that the cost of good lighting for stations, approaches, goods yards, &c., at a minimum of ·5 candle feet is well within the range of practical economy for by such illumination, time is saved, traffic is accelerated, accomodation is improved, safety is secured, all gains to set off against a negligible extra cost.

The lighting of the tube stations is undoubtedly good and sufficient, but it

seems possible that better and cheaper results might be obtained by indirect lighting securing shorter halts, and more permanent lighting of the advertisements with less colour distortion.

MR. T. E. RITCHIE (*communicated*): I do not consider that any system of lighting can be deemed satisfactory, at all events, for large terminal and important main line stations which does not ensure the satisfactory illumination of the roof and upper portions of the structure. Nor do I think that any railway company will, in future, be allowed by the members of the Bill Posters and Advertisers Association to ignore the question of the satisfactory lighting of the posters and advertising signs displayed upon its premises and the receipts from which constitute so important a factor in railway finance.

From these points of view, I consider the minimum of ·25 of a foot-candle on a plane 4 ft. above the ground referred to in the paper, decidedly inadequate, and would suggest that it should, at least, be doubled.

Mr. Harrison appears to suggest, from the references in his paper to flame arc lamps, that the use therein of dioptric inner globes, which he designates as "special globes," constitutes something of a difficulty. This is not the case. Dioptric globes are not special, but standard, do not add either to the cost of the lamp or of its maintenance, and are quite as usual and ordinary a part of the lamps with which they are used, as are the reflector fittings used with incandescent lamps.

I should like to ask Mr. Harrison exactly what he means by the expression "very high candle-power," as used in his statement that whilst "with tungsten lamps and suitable reflectors it is possible to obtain 1·5 candles per watt at the angles mentioned." With "flame arc lamps unless very high candle-power, 2-2·5 candles per watt at an angle of 17 degrees is rarely exceeded."

Flame arc lamps are available from which very much more satisfactory results are obtainable. The "Excello" for instance, with a consumption of only 264 watts considerably less than that of a 300 c.-p. metal lamp, gives, when fitted with an opalescent globe, no less than 6 candles per watt, whilst with a clear glass outer globe, such as would, I presume, be used with the incandescent lamps, the efficiency would, of course, be still higher.

I must also take exception to Mr. Harrison's bald, and as I consider inaccurate statement that the running cost including renewals, labour, &c., is less in the case of the tungsten lamps, than flame arcs. The exact contrary is, as far as my own experience and that of many large users go, the case, and as this aspect of the question is of the greatest importance, not only to railway companies, but also to all large users of light, I trust that Mr. Harrison will enlighten us as to the figures upon which his assumption is based. What, for instance, has he taken as the average consumption of the tungsten lamps in watts per M.Horizontal C.-P.? What is the economical limit to which such lamps should be used? and what is the average economical life (*i.e.*, the hours of burning during which the consumption does not exceed the predetermined limit, say 1·5 watts per M.H.C.-P.) obtained?

In conclusion I would remind the members of the Society, that we have at the moment at the Waterloo Station of the L. & S.W. Railway, an opportunity as unique as it is valuable, of critically comparing under actual working conditions, station lighting by both small and large units furnished by both gas and electricity.

MR. JOHN DARCH (*communicated*).—There is, perhaps, no place that affects a larger number of people than the railway station, and few places where excitement and haste are so often converted into worry by bad lighting—lighting that is not only insufficient, but so arranged as to render vision difficult, and thereby to court danger.

The exact degree of illumination, on which straws are being split, seems to me to be of far less importance than an otherwise rational arrangement of lights. The traveller wants to see, and ability to do so depends more upon absence of excessive contrast than

upon any particular intensity of illumination. There is, perhaps, more light thrown about Piccadilly Circus than in any railway station, and yet it is difficult to see clearly and dangerous to move in. If Piccadilly Circus were illumined by moonlight alone,* we should be able to see everything more easily and move about with greater safety. Absolute intensity, as Fechner has shown, is not appreciable, it is relative intensity that governs the case, and we can see with equal comfort in 2,000 or 2 foot-candles, so long as the light is diffused. Let us, therefore, trouble ourselves less about determining any particular standard and go for rational illumination.

The tube stations have been mentioned as being more satisfactory, as the excellent photographs and particulars provided by Mr. Dow amply confirm. Ability to see easily depends upon a large measure of diffusion, and the absence of excessive contrasts, and this is just where the railway station fails. There is always a background of darkness pierced by dazzling points of light, usually placed directly in the line of vision down the platform, and which successfully prevent one seeing just those things that, in the hurry, should be seen easily. The light on faces is hard and patchy, and shadows dense. The overhead gloom in some stations is often so intensely black that it is impossible to see the roof.

Most of our stations have been illuminated on street lighting principles, and the suffering traveller has had to put up with tenfold or greater diversity factors. What should we think of the illumination of a public hall varying from 2 to 0·2 foot-candles? The British Museum tube station, with its average of 1·2 and its minimum of 1·05, would probably not vary more than from 1·05 to 1·4. The fact is that the railway station is no exception to those rules which govern the art of illumination, and distinction of vision and comfort will only be obtained by observing the following :—

1. That no exposed lights be permitted in the field of vision, and if shades be used, none should pass more than 0·1 c.-p. per square inch of light.

2. That all available surfaces, particularly ceilings, should be light in tint, and employed for diffusion.

3. Special lighting for clocks, timetables, &c.

4. The question of large or small units, as Mr. Harrison says, will depend on the character of the station. In lofty roofed stations let us have arc lamps or high-pressure gas, well up out of the line of vision, and banish the overhead gloom by painting the roof a light colour, and doing away with over reflectors. In smaller and low-roofed stations, small units should be frequent, without over reflectors, and so placed as to illumine every available reflecting surface. This will make it cheerful and attractive.

5. After all this, the question of intensity can be considered, and it will afford better results for the expenditure. Personally, I think 0·25 a miserable illumination, one ought to be able to read one's ticket; but uniformity, as at some tube stations, is of more importance—better a uniform 0·25 than a 0·5 varying to 5. Every clock and important notice should be illuminated, and time tables should have 3 foot-candles.

Mr. Haydn T. Harrison, who curtailed his reply owing to lack of time, said that they owed Mr. Dow many thanks for the experiments he had made. He (Mr. Harrison) had carried out a great number of tests himself, but not in the detailed manner in which Mr. Dow appeared to have carried out his. The photometer he used was one that he carried about in his pocket, and he had gone from station to station indiscriminately all over the country; therefore, where Mr. Dow tested 5 stations, he had probably tested 50. The whole object, however, was to find out the variations, and it was most interesting that in the case of the stations which each of them had tested, the results were practically the same, so that it showed that his rough tests were not very far out. The Central London tube, unfortunately, was one that he did not test. He par-

* Lewinson gives moonlight with a moonlit sky as averaging ·014 c. ft.

ticularly wanted to find the station with the Holophane reflectors in it, but had forgotten which station it was, and did not propose going down the whole of the line looking for it.

The problem on tube railways was more or less a confined one. There was a definite height of station which controlled the height of the lamps. Moreover, they had very cheap power, so that from these two factors resulted a very high degree of illumination. But he thought this high degree of illumination in the tubes would make the public want it on open stations, and the time would come when the public would cry out for more illumination than they had at present on main line railways.

He was sorry that Mr. Roger Smith had disclaimed that minimum value of 0·25 foot-candles. The paragraph which he gave in his paper in inverted commas was one he had copied from Mr. Smith's paper. He had simply argued on that, and as a matter of fact, the figure of 0·25 was one that was actually in vogue at the present time. Mr. Roger Smith, in his paper had said that any station illuminated below 0·25 was poorly lit, therefore Mr. Harrison laid considerable stress on his suggestion that all stations should have the opportunity of getting 0·25 when it was wanted. There was no reason why, at a wayside station, they should not have 0·25 for the ten minutes that the train was in, and then let the station go to sleep again.

He agreed with Mr. Roger Smith that sometimes it might be better to light station roofs, because if they lit the platforms only, and left the roofs in darkness, somebody might complain. Therefore, he was to a certain extent in favour of having a few big units to give the general illumination of the station. If they had big units only, and these high up, they would have to be exceptionally big, otherwise there would be low average illumination; therefore, if this form of lighting was considered necessary, small units should be installed to increase the illumination of the platforms when the trains came in. In the case of gas, high pressure gas could be adopted for the roof lighting, and smaller gas units for the actual lighting.

With regard to the height of lamps in goods yards, he had mentioned 50 ft., but there was a little confusion there because they would notice that he had been dealing with the lighting of goods sheds, and then, without a separate heading, he went on to the illumination of shunting yards.

Next, as to the height at which measurements should be taken. Sometimes it was called 4 ft., and sometimes 40 in. To be consistent with foreign practice it should be 1 metre. Mr. Trotter had reminded him of the discussion which occurred some time ago —Mr. Roger Smith was in it too—on the question of vertical and horizontal illumination, and he had then written a whole paragraph in his paper on this subject, but crossed it out, because, looking at Mr. Fowler's paper read in 1896, he found that this subject was referred to, and Mr. Fowler's view, he thought, was the right one, namely, that if the horizontal illumination was sufficient it could be taken that the vertical illumination would probably be so too, and so he thought he would not raise that old discussion again. He had not stated that high candle-power lamps 50 ft. high were good for lighting goods yards. It was in connexion with shunting yards that this had been mentioned, and he took it that in shunting yards there was no deciphering of labels or anything of that sort. They only required sufficient illumination to see the direction of the points, and so on. By goods yards he naturally referred to a place where labels had to be deciphered, and similar class of work carried out.

Mr. Jones had referred to table 2, in which he asked why he gave the candle-power at the particular angle. It was because it happened to be the important angle for minimum illumination, namely, where the rays from the two lights converged, and those were the points where the candle-power of the lamps should reach the maximum. He was sorry to hear Mr. Jones mention average illumination, as he thought that bogey was dead. If they were to give their average illumination they would always

have the same old trouble, namely, 5 ft. candles in one place and 0·001 in another, which meant absolutely nothing, and the question of average illumination would, he was afraid, have to be cut out of these calculations, otherwise they would never get to any satisfactory basis.

Mr. Harrison (*continued and communicated*).—

Mr. Herbert Jones's division of different classes of railway stations, and his suggestions *re* illumination of same, is interesting from an electrical point of view, but can hardly be considered to accord with more modern methods of illumination—for example, his terminal stations would have a lower minimum illumination than his important junctions. The question of illuminating station roofs is referred to under Mr. Ritchie's remarks as regards the author's results being based on minimum illumination. I regret that Mr. Herbert Jones did not agree that anything in excess of this minimum was waste, but would like to ask if he had anything to aim at higher than an "illumination ratio" of unity.

I much appreciate Mr. Trotter's remarks, and am glad to have his support in the question of lighting by small units. The fact that shadows are cast by trains standing at platforms when large units of lights were used is one of considerable importance, and should be carefully borne in mind, as these shadows occur at a very dangerous point, namely, the edge of the platform.

Mr. Grove's remarks were of special value, being based on the results of their actual experiments, the figures relating to the saving which resulted from the replacement of arc lamps by tungsten lamps being particularly interesting. The question of illuminating advertisements was of course important, but could hardly be considered as part of the station lighting, as it should be charged against advertising revenue.

Mr. John Severs' remarks concerning tube station lighting were important as suggesting a good reason why these stations could hardly be put into the class of ordinary railway station lighting—namely, the fact that the passengers entered them in daytime, when they were used to a very high standard of illumination. I was very pleased to hear the results communicated by Mr. Clark of the lighting at Victoria Station, as they exactly agreed with my own tests.

I am very glad to have Mr. Frank Bailey's support of the plea for all-round better illumination. There is no doubt it will come automatically in time, but only by bringing comparisons to the notice of railway engineers; the progressive companies have already realized the importance of this subject, and it is becoming recognized that a uniform good standard of illumination can be hastened, and I hope that this paper will assist to bring about this result, by which both the public and the railway companies would benefit.

In reply to Mr. J. R. Fletcher's remarks (communicated) I was pleased to note that attention had been called to the already improved results to be obtained by the tungsten lamps; and also that Mr. Fletcher is arranging experiments which would facilitate the proposal put forward, namely, an efficient control over the illumination results for varying conditions of traffic.

Mr. C. R. Williams's communication is of special interest. It forms a valuable addition to our present knowledge, and should help considerably in forming some definite lines along which to work.

Mr. Justus Eck's mention of lamps placed 13 ft. high as bound to interfere with observation of signals is an interesting point. The opinion of railway engineers should be taken on this matter, as it will be noted that 12 ft. to 13 ft. is a very usual height for lamps in railway stations.

Mr. T. E. Ritchie in his communicated remarks states that he does not deem satisfactory any system which does not ensure the satisfactory illumination of the roof and upper portion of the structure. Unfortunately, I have had no opportunity of making measurements of the illumination of the roofs of

any railway station, neither had it occurred to me that their illumination would interest anybody, except, perhaps, for æsthetic reasons. Neither was it intended that this paper should deal with the illumination of bills, posters, &c., which should be charged against a different department to that of the railway station proper.

Mr. Ritchie's suggestion concerning the inadequacy of 0·25 foot-candles has been dealt with in the discussion generally. I am glad to hear that dioptric globes have become standard, as up to a few months back I have had considerable difficulty in arranging for them to be fitted to many makes of arc lamps, despite the fact that I so often specify their use.

By very high candle-power is intended lamps exceeding 2,000 c.-p. in the directions mentioned. I observe that Mr. Ritchie classifies as inaccurate my statement *re* the relative running cost of arc and tungsten lamps. These statements are, however, based on actual practice, and can be verified at any time. M.H.C.-P. does not enter into the calculation as the whole of the figures in the paper were based on minimum horizontal illumination derived per unit length of platform.

Mr. John Darch (*communicated*) obviously wishes to treat a railway station to the same degree of illumination and with the same pleasing effects as a concert hall or theatre; unfortunately, this is quite out of the realms of possibility, and Mr. Darch will note that even the low degree of minimum illumination proposed is by many considered too much.

As regards illuminating the roof sufficient has been said, but as a background of darkness is not considered objectionable in the open air, the author fails to see that it can cause much trouble in a high-roofed railway station.

Official Notice of Next Meeting.

THE next Meeting of the Illuminating Engineering Society will take place at 8 o'clock at the House of the Royal Society of Arts (John Street, Adelphi, London, W.) on **Tuesday, February 20th, 1912,** when a discussion on **Shoplighting** will be opened by short papers by **Mr. N. W. Prangnell** (Metropolitan Electric Supply Co.) and **Mr. A. E. Broadberry** (Tottenham Gas Company).

Annual Dinner.

THE **Annual Dinner** of the Illuminating Engineering Society will take place on **Thursday, February 15th, 1912,** at the Trocadero Restaurant, Piccadilly, W. (7.15 for 7.45).

The price of Tickets will be 10*s.* 6*d.* (exclusive of wine), and it is earnestly hoped that members will make a special effort to be present.

It will also facilitate the arrangements of the Committee if members will kindly **apply for tickets as early as possible** to the Hon. Secretary (Mr. L. GASTER, 32, Victoria Street, London, S.W.)

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

The Benjamin Daylight Unit, with Wratten Screen.

An interesting novelty now being put upon the market by **Benjamin Electric, Ltd.** (117, Victoria Street, S.W.), is the new lamp for matching colours, &c., which was recently described by Dr. Kenneth Mees at a meeting of the Illuminating Engineering Society. The unit (for which Benjamin Electric are sole agents) consists in an ordinary tungsten lamp covered with a mat steel reflector which concentrates the light downwards, and having below the lamp a special Wratten filter, which converts the colour of the light from the tungsten lamp into a very close resemblance to daylight. The general appearance of the arrangement is shown in the figure.

We are informed that exhaustive tests on this lamp are now being carried out by experts in colour and dyeing work, and that it is expected to prove of very great service in all trades in which the correct matching of delicate shades of colour is essential.

We are asked to mention that the word "Luxogen" has been registered as the telegraphic address of the Benjamin Electric Co.'s offices and showrooms at 117, Victoria Street.

The Story of the Welsbach Light.

Under the above title the **Welsbach Light Company, Ltd.** (Welsbach House, 344-354, Gray's Inn Road, London, W.C.), have issued a well got-up booklet, in which alternate pages are occupied with interesting notes on the history and methods of manufacture of incandescent mantles, the remaining pages being devoted to particulars and prices of the various mantles and fittings brought out by the Company. We note with interest the reference to the pioneer work of Baron Auer von Welsbach, and following this is a concise account of the making of a mantle, with illustrations of the various stages. The brilliancy and durability of the Welsbach mantles may be largely attributed to the excellence of the manufacturing processes.

We have also received from the Welsbach Company a leaflet giving particulars of their latest high candle-power lamp for working on low pressure, the efficiency of which is said to be as much as 40 c.-p. per cubic foot of gas.

A Novel Illuminated Sign.

Messrs. Engineering & Arc Lamps, Ltd. (of St. Albans, Herts, and Chingford, Essex) draw our attention to an advertising sign device which attracted a considerable amount of notice at the recent Electrical Exhibition at Olympia. Its chief feature is an arrangement for tapping the glass of the sign during the period in which it is left in darkness by the flashing device. In this way the attention of any one passing is almost certain to be attracted, and the flashing sign does the rest.

The same firm (formerly known as the Gilbert Arc Lamp Co.) have also sent us a pamphlet dealing with the various types of "Beacon" arc lamp manufactured by them.

Incandescent Electric Lamps.

We have received from the **Armorduct Manufacturing Co., Ltd.** (Farringdon Avenue, London, E.C.), a copy of their latest and very complete list of "GRAL" METAL FILAMENT LAMPS and fixtures for same. Among the accessories supplied by this firm may be mentioned the "Gral" auto-transformer, some specially designed globes for clusters of high candle-power lamps suitable for interior or exterior lighting, and, at the conclusion of the list we notice some examples of Holophane shades and Holophane-Benjamin steel reflectors.

The General Electric Co., Ltd. (67, Queen Victoria Street, London, E.C.) draw our attention to the fact that they are now supplying OSRAM LAMPS with DRAWN-WIRE FILAMENTS, which retain all the good features of their earlier lamps whilst possessing a largely increased mechanical strength.

"Wotan" Lamps.

Under the above name **Messrs. Siemens Bros.' Dynamo Works, Ltd.** (Tyssen Street, Dalston, London, N.E.), have introduced a complete line of drawn-wire metallic filament lamps ranging up to 250 volts and to 600 c.-p. "Wotan" is the new name for the one-watt lamp which was formerly made in certain candle-powers and voltages only. We have received a price-list of these lamps in a very handy form, and giving particulars of the types in common use. Messrs. Siemens Bros. are carrying out an elaborate scheme of advertizing in connection with Wotan lamps, and they have sent us a copy of a full-page advertisement which appeared in the 'Daily Express' for January 19th. This, we understand, is part of their scheme for bringing the new line of lamps before the notice of the consumer direct.

Messrs. Siemens also inform us that they have reduced the price of high voltage "Tantalum" lamps from 3*s.* to 2*s.* 6*d.*

Reduction in the Price of Gas.

The Gas Light & Coke Co. (Horseferry Road, Westminster, S.W.) have announced a further reduction of 1*d.* in the price of gas supplied by them. This reduction—following on a similar lowering of price each January for four successive years—brings the charge down to 2*s.* 6*d.* per 1,000 cubic feet. We understand that they hold large stocks of coal, and the consumers in their district need have no fears on account of the announcements of higher prices and the prospect of a temporary stoppage in coal supplies.

B.T H. Booklets.

We have received a copy of a new booklet just issued by the **British Thomson-Houston Co., Ltd.** (83, Cannon Street, London, E.C.). This booklet contains a concise description of lighting by Mazdaliers—the name given to a complete lighting set, consisting of a Mazda lamp, with a properly designed reflector and gallery to hold the reflector in correct position.

The many useful applications of these fittings in office, shop, and home are interestingly shown by a number of illustrations with pertinent text comments.

Another booklet which we have received popularly describes the new Gem lamp of the British Thomson-Houston Company. This lamp, as we have already noted in our columns, has all the characteristics of low first cost, durability, and simplicity of the ordinary carbon lamp, but secures a saving of 25 per cent in current for the same illumination and lamp life—the 16 c.-p. Gem lamp consumes 45 watts with a life of 1,500 hours. The new booklet summarizes in a very concise manner the merits and advantages of the Gem lamp. It is interesting to note that this lamp has effected in one step a gain in efficiency equivalent to the previous twenty-five years' improvement in the ordinary carbon lamp. The British Thomson-Houston Co. may be congratulated on the attractive design of their advertizing booklets and lamp publications.

Finally, we would mention a booklet entitled 'British Press Opinions of Mazda Drawn Wire Filament Lamps,' in which the various comments and opinions of the Press have been abstracted and published, thus giving a concise and readable account of the great improvement in electric lamps resulting from the introduction of the drawn-wire filament.

Colour-Matching Arc Lamps.

Messrs. G. Braulik (8, Lambeth Hill, Queen Victoria Street, E.C.) have sent us particulars of several types of arc lamps fitted with special globes and designed for use in dye-works, colour-printing establishments, and other factories where colour discrimination by artificial light is of importance.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

THE space allotted to the Review of the Technical Press is necessarily restricted this month, but not very many novel articles have appeared.

J. DARCH, in a recent paper before the Society of Architects, summarizes some general information on illuminating engineering, and makes some interesting suggestions regarding the use of shades and the avoidance of cumbersome chandeliers, &c. He also points out the great opportunity before the architect in illuminating engineering if he would study the subject.

Among American items we note the modification in the title of the American *Illuminating Engineer*, which now appears as *Good Lighting*. As usual there are a number of short and readable illustrated articles on various installations and types of fixtures. The editorial is of exceptional interest, quotations being made showing the need for great improvement in the lighting of the cloak and suit industry.

The Electrical World (Dec. 23) shows some interesting views of the Pabst Theatre (Milwaukee), which is lighted by indirect units of a distinctly decorative kind. *The Electrical Review* (Dec. 23) of New York deals with the 'Value of Photography in Illuminating Engineering,' and J. R. CRAVATH (*Elec. World*, Jan. 13) contributes some experiences on the diffusion of light in interiors.

ELECTRIC & GAS LIGHTING.

In electric lighting we need only notice several articles of a general character, notably the summaries in the American journals of progress during the past year.

In gas lighting we may remark the closing phases of the discussion with the Engineering Correspondent of *The Daily Telegraph* in *The Journal of Gas Lighting*, which has served to illustrate the debatable area over which controversies on gas and electric lighting commonly range. The retrospect for the past year in this journal is also interesting.

Several articles in the German and American press deal with the artificial silk mantle, that by GULBRANDSEN (*Prog. Age*, Jan. 15; *Am. Gas Light Jour.*) forming a useful summary of progress in this respect. Another interesting article in *The Progressive Age* is that by R. M. THOMSON (Jan. 1), who points out the value of the so-called "deck-lighting" for shops, in which the gas lamps are ranged above a diffusing glass roof, so as to illuminate the goods, but to be completely screened and separated from the contents of the window. C. E. UMNACH's contribution on 'The Modern Gas Fixture' (*Am. Gas Light Jour.*, Jan. 15) also leads to a readable discussion, in which E. L. Elliott takes part. Much is said on the recent development of gas fixtures, both practically and æsthetically, but the chief point seems to be the general approval which indirect gas lighting with powerful lamps is now receiving.

List of References:—

ILLUMINATION AND PHOTOMETRY.

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Darch, J. Illumination as a Study for Architects (Paper read before the Society of Architects: *J.G.L.*, Jan. 16; *G.W.*, Jan. 13).
Editorials. Rural Street Lighting Contracts (*Elec. Rev.*, N.Y., Dec. 16).
Improved Lighting in the Cloak Industry—Lighting Companies as Social Reformers, &c. (*Good Lighting* [*Illum. Eng.*, N.Y.], Jan.).
Good Reading Lights—and Bad Ones (*Good Lighting* [*Illum. Eng.*, N.Y.], Jan).
Photometry and Illuminating Engineering during 1911 (*Elec. World*, Jan. 6).
The Uniform Design of Street Lighting Standards (*Elec. World*, Dec. 16).
The Value of Photography in Illuminating Engineering (*Elec. Rev.*, N.Y., Dec. 23).

Lighting the Panama Canal (*Elec. World*, Dec. 25).
Gas and Electric Schedules in New York State (*Elec. World*, Dec. 23).
The Pabst Theatre, Milwaukee, U.S.A. (*Elec. World*, N.Y., Dec. 23).

ELECTRIC LIGHTING.

Thompson, H. F. J. Street Lighting (*Elec. Rev.*, Jan. 5).
Wikander, E. Elektricität u. Gas (*E.T.Z.*, Jan. 4).
Electric Lighting and Illuminating Engineering (*Elec. Rev.*, N.Y., Jan. 6; *Elec. World*, Jan. 6)
Fortschritte in der Glühlampen-technik (*Z.f.B.*, Jan. 20).

GAS, OIL, AND ACETYLENE LIGHTING, &c.

Böhm, C. R. Die Bedeutung des Kunstseideglühkörpers und seine Bedeutung (*Z.f.B.*, Jan. 20)
Editorial. Cheap Gas Illumination in Westminster (*J.G.L.*, Jan. 16).
Godinez, F. L. Originality in Modern Gas Lighting (*Prog. Age*, Dec. 15, Jan. 15).
Gulbrandsen, S. Manufacture of Mantles from Artificial Fibres (*Prog. Age*, Jan. 15; *Am. Gaslight Jour.*, Dec. 25).
Thomson, R. M. Decked Window Lighting (*Prog. Age*, Jan. 1).
Umnach, C. E. The Modern Gas Fixture (*Am. Gaslight Jour.*, Jan. 15).
A Retrospect of Gas Lighting for 1911 (*J.G.L.*, Dec. 26).
Hampstead Public Lighting (*J.G.L.*, Jan. 9, 16).
The Daily Press and Rival Industries (*J.G.L.*, Jan. 16).
The Welsbach High and Low Pressure Gas Lamps (*J.G.L.*, Jan. 23).
Gas and Hygiene (*G.W.*, Dec. 30).
Acetylen im Konkurrenzkampe (*Z.f.B.*, Dec. 30).

CONTRACTIONS USED.

Elek. u. Masch.—*Elektrotechnik und Maschinenbau.*

E. T. Z.—*Elektrotechnische Zeitschrift.*

G. W.—*Gas World.*

Illum. Eng., N.Y.—*Illuminating Engineer of New York.*

J. f. G.—*Journal für Gasbeleuchtung.*

J. G. L.—*Journal of Gaslighting.*

Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

Some Publications Received.

The Engineering Diary.—The January issue contains, in addition to a fairly complete list of meetings of technical and scientific societies, a number of pages devoted to concise information on various matters of interest to engineers. We notice in particular the first section of a very full table of illumination intensities required for various places, given in foot-candles. This is to be continued in the next issue.

Im Jahrhundert des Gases.—This volume, published by the Zentrale für Gasverwertung in Berlin, deals with the progress of the gas industry in Germany during the last hundred years. A series of articles in popular style illustrate the varied applications of gas in the home, the factory, the laundry, &c., and its use in street lighting is also dealt with.

Among other publications, we have also to acknowledge the receipt of the following: *The Journal of the Royal Society of Arts, The Physical Review, The Proceedings of the American Institute of Electrial Engineers, The Proceedings of the American Academy of Arts and Sciences, Zeitschrift für wissenschaftliche Photographie Photophysik und Photochemie, The Proceedings of the Tokyo Mathematico-Physical Society.*

REVIEWS OF BOOKS.

THE MODERN BIOSCOPE OPERATOR.

Messrs. Ganes, Ltd., 85, Shaftesbury Avenue, London, W., May, 1911.

The first of this work appeared in Feb., 1910, and it is explained that the rapid strides in the Bioscope industry have rendered a second edition necessary.

The historical account of the development of the moving picture in the first few pages is interesting, and the subsequent chapters deal with the more technical aspects in a practical manner.

Chapter II. is devoted to the film, and some simple precautions are detailed which must be attended to in its storage and handling. The next few chapters deal mainly with the manipulation of lime light and the arc lamp. There follows an account of the electrical installation. The value of the rotary converted on A.C. systems (a matter not always sufficiently appreciated) is emphasized, and particulars are given of the uses of petrol-driven electric generating sets. The remainder of the book is devoted to the care and working of apparatus and the optical system of the bioscope, and the book concludes with a summary of the legislation bearing on the subject.

The work is written in a simple and practical manner. It will doubtless continue to prove of value to the expert in this work, and also contains matter of interest to others who only touch the fringe of the subject.

Another small pocket publication from the same firm, **The Bioscope Electrician's Handbook,** by J. W. Barber, A.M.I.E.E., deals in a succinct manner with the electrical part of the subject.

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ELECTRICITY · ACETYLENE · OIL · GAS

The
ILLUMINATING
ENGINEER

Edited by
LEON · GASTER

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EDITORIAL.

Shoplighting.

The meeting of the Illuminating Engineering Society on February 20th, dealing with shoplighting, may be considered a complete success. The occasion was remarkable for the fact of there being on the same night papers read by representatives of gas and electric lighting on the same subject. At one time people would have scouted the possibility of conducting such a discussion on amicable lines. Yet, as a matter of fact, nothing could have been happier than the non-controversial methods adopted in the two papers, and the example of the authors in this respect was followed throughout the discussion. We hope that the precedent set on this occasion will be observed in all our future meetings.

The discussion was of a very spirited and interesting character, and if it revealed some marked differences of opinion, this only shows how needful discussion of the subject must be. In the time available it was not possible for every one to speak who desired to do so. We should therefore like to point out that in this issue we are only reproducing the papers, and that it is proposed to deal with the discussion in the April number. Members will therefore have ample time to read over the papers and to send in writing any contributions they desire to make to the discussion.

We may point out that the lighting of the interior of the shop and the windows present quite distinct problems. In both cases, no doubt, personal taste plays a part, just as it does in many other branches of lighting. We are inclined to think, however, that the difficulty of forming definite rules is less in the case of the inside of the shop than in the case of a show-window.

There are certain fundamental rules regarding the avoidance of glare from exposed brilliant sources, the concentra-

tion of light in the desired directions, and the correct placing of lamps, which must almost invariably be observed. Most people, for example, would agree as to the need for a good illumination on the counter and on any shelves there may be lining the shop. Judging by common experience, one would be inclined to suppose that the provision of, say, 4 to 8 foot-candles would usually enable the purchaser to see all that was needed of all but the darkest or most minute material. If necessary some latitude would naturally be provided for such trades as clothing or drapery, where great extremes in the reflecting power of materials are frequently met with.

It is true that, as Mr. Prangnell points out, merchants will often be found to utilize different amounts of light. Yet the figures he quotes do not differ more than those which could be quoted for some schools and libraries. On closer examination it would probably be found that, say, 2 foot-candles, even though the merchant raised no complaint, was hardly enough; and that 10 foot-candles was, except in very exceptional circumstances, more than he really needed. It may be noted, too, that the fact of the merchant being satisfied does not necessarily imply, in all cases, that his light is just right. His conception of comfort in illumination may be a poor one, and in this case he requires to be educated to demand more. Or, on the other hand, he may receive an excessive amount of light without knowing that if the illumination were considerably less he might still get excellent results, and at the same time save the superfluous expenditure.

However, all that one would wish to establish at present would be a desirable *minimum*. Provided the lamps were properly arranged, this value might, and doubtless often would, be exceeded without detriment, as some of Mr. Broadberry's data in particular clearly suggest.

One must also bear in mind the question of artistic effects, which play an important part in the lighting of the interiors of many shops in the west end of London. In such cases it is clearly necessary to allow a certain additional expenditure of energy, in view of there being a certain loss of light entailed by these displays.

Show-Window Lighting.

It is when one comes to the consideration of show-window lighting that one recognizes the difficulty of framing a standard. If, indeed, the light were demanded solely to enable the public to view the goods the problem might be easier. But the illumination also serves the purpose of advertisement and spectacular effect; it has passed the limits of necessity and become a luxury. Naturally one finds, therefore, that the amount of light devoted to a window will vary according to the class of goods, the nature of the street (*e.g.*, on the wealth of the merchants using it), the strength of the public lighting in that locality and other circumstances.

Provided the light is used in a reasonable way, however, there seems little reason to set a limit on the intensity of illumination afforded. It is when the light is exhibited to the eye in the form of concentrated bright spots at close quarters that the illuminating engineer raises an objection. His criticism is based on the perfectly reasonable contention that such lights so placed defeat their own object; they may possibly attract the customer, but they also render it difficult for him to see the contents of the window when he has arrived.

Several of the speakers in the discussion expressed the conviction that the merchant of to-day considers expense of little object if he can make his window supremely attractive. A well-dressed and well-lighted window is one of the best advertisements, and, by the increased sale it promotes, contributes to the rents of the premises. A badly lit window, on the other hand,

may be a positive loss to the merchant, for it means that he is not getting the full value for the expensive site obtained.

The rapid incursion of lamps of high candle-power has led people to rely on brilliancy pure and simple as a means of attracting attention. For our part, we are disposed to think that this is a passing phase. In the near future, one may confidently predict, mere *brightness* will prove of little value as an attraction. The merchant will rely much more on special artistic applications of light, the use of novel illuminated signs and window displays, and the cunning use of colour harmonies in order to attract notice. We already see a growing tendency to make use of concealed lighting, *i.e.*, to make the illuminated goods the prominent objects and not the lamps themselves. Shoplighting, in short, is coming much closer to the methods of the theatre, where it is regarded as self-evident that any bright illuminants in the auditorium only tend to diminish the effectiveness of the stage.

One more analogy with stage lighting may be seen to exist. In the theatre the scenery, the dresses of the actors, and the light-effects are considered conjointly. Want of co-operation between the requirements of the stage manager and those of the lighting expert would lead to hopeless chaos. In the same way it is probable that window-dressing and window-lighting will in future be considered together, and there is an excellent prospect for the man who understands both these arts.

The Annual Dinner of the Illuminating Engineering Society.

The Second Annual Dinner of the Illuminating Engineering Society since the formal inauguration of the Society in the autumn of 1909, took place on Thursday, February 15, and an account of the proceedings will be found on pp. 152–156. It is most interesting to look back over previous events in the history of the Society, and to observe how the note struck in the speeches on these occasions has gradually changed.

The first definite intimation of the proposed founding of the Society was given in the paper read by the writer before the Association of Engineers in Charge, at the end of 1907. In 1910 the first Anniversary Dinner was held. It was recognized that the Society was definitely started on its career of usefulness and the representatives of kindred societies who were present on that occasion gave most encouraging support to its intentions. The second dinner of this kind has now taken place. Two years have elapsed since the First Anniversary Dinner, and the Society has had an opportunity of proving its usefulness by actual work, and of carrying into execution the ideas of co-operation with other societies, which it has from the first entertained.

We need not dwell here upon the gratifying and suggestive speeches on this last occasion. Readers will find an account of them elsewhere in this number. But we should like to lay special stress on the spirit of co-operation which pervaded them, and the expressed recognition that our Society does work which the constitution of no other body would allow it to perform. So far from being an unnecessary addition to the number of specialized societies, it is really a link between existing ones. Moreover it also affords a common ground for the engineer and the general public—between the producers of lighting apparatus and the actual users of it—which is absent in the case of purely professional and technical bodies. The interest which recent discussions have awakened among merchants of many classes, librarians, school authorities, &c., provides an example of the Society's methods, and we hope that the coming discussion on other subjects in which the Society is engaged, will be equally fruitful in this respect.

The presence of our President, Prof. S. P. Thompson, as chairman, greatly

added to the enjoyment of the evening. Needless to say the occasion was taken to acknowledge the great services which he is rendering to the Society during these critical years of its existence, and we earnestly hope that his support and guidance will be continued for many years to come.

The Training of Men for Responsible Commercial and Engineering Positions.

The perennial subject of the training of men for responsible engineering and commercial positions found its way into many of the speeches delivered at the Annual Dinner of the General Electric Co., on February 10th, when, in the speech of the evening, Mr. Hirst expressed the wish that men from the public schools and the universities would take a larger share in industry.

It is gratifying to find the managing director of a great company realizing the need for better training and more scientific equipment in the rank and file of the electrical industry. We feel sure that any efforts that the General Electric Company can make to elevate the standard in this respect will be richly rewarded.

At the same time we rather share the doubts of the other speakers on this occasion whether the present system of education, and the circumstances of Oxford and Cambridge University life favour engineering as a career. The training and age of the men at the Universities inclines them, quite naturally, to enter the liberal professions, except in special cases in which a tempting commercial or engineering opening is provided for them. If university men are to be attracted to an industrial career, employers must be prepared to give facilities and remuneration considerably above those usually offered at present.

On the other hand, students who are leaving technical colleges and institutions (and there is a considerable sprinkling of public school men among them), are in a different position. They are younger, possibly more prepared to "rough it," and unquestionably educated in a manner more directly adapted to engineering work. That there are defects in their education is doubtless true, but these defects could be largely overcome by earnest young men if their employers cared to encourage them to do so. In the past engineering institutions have suffered neglect, but employers are now more alive to the advantages of scientific training. At the present moment the difficulty is not so much that the existing institutions are faulty, although there are doubtless matters in which they could be improved; it is rather that there are not enough of them. A very brief examination of the long list of existing colleges and technical schools in Germany devoted to engineering and industry, shows the vast superiority of the conditions in that respect. They are more numerous, better equipped, and better staffed.

Moreover, it is necessary to remember that the system in Germany and other Continental countries is of long standing. Most of the men actually engaged in industry, the directors, heads of departments, even the foremen, are men who have enjoyed technical education. Naturally, therefore, they appreciate its advantages, understand the outlook and limitations of the college-bred man entering business, and encourage him in a suitable manner. Employers in this country are apt to think that education ceases when a lad enters their works; those of them, however, who organize means of training selected men for certain classes of work, reap the ultimate benefit.

In conclusion, we may add that the Illuminating Engineering Department provides an excellent example of this kind of specialization. In this work there is a great need of trained men with wide ideas, and much remains to be done in the way of encouraging men to educate themselves in this department. LEON GASTER.

Review of Contents of this Issue.

At the beginning of the Technical Section will be found a report of the paper entitled **Illumination as a Study for Architects**, recently read by Mr. John Darch before the Society of Architects. The author first lays stress on the responsibility of the architect in lighting matters, and suggests that, especially where æsthetic aspects are of importance, much more might be done to display the beauties of buildings. Mr. Darch states some of the principal rules relating to the position, shading, and colour of illuminants. Instruments for measuring illumination are also referred to, and several cases are instanced in which definite measurement would be useful. The author concludes with some references to practical applications, and a brief summary is given of the discussion which followed.

On p. 117 Mr. E. Kilburn Scott contributes an article on the **Electric Lighting of Streets having Permanent Verandahs,** in which he describes some of the methods employed in Australian cities, and discusses their respective advantages. The difficulty of using central arc lamps for streets of this kind is indicated by a diagram, and the author proceeds to show that, taking into consideration the present-day efficiency of tungsten lighting, the best method for lighting verandahs is by means of rows of metallic filament lamps, arranged along the edge so as to throw light on the road as well as on the pavement. In order to reduce the number of wiring points, tubular lamps are suggested, and the author works out the cost of lighting half a mile of street in this way.

Some account of the **Lectures on Illuminating Engineering** at University College, Regent Street Polytechnic, and the Northampton Institute appears on p. 119. Prof. Clinton deals first with the production of light and the laws of radiation, and subsequently with the subject of Photometry. The lectures by Mr. J. S. Dow are occupied with the subject of colour and the discussion of practical problems in lighting, both by daylight and by artificial light. Reference is also made to recent lectures at the Northampton Institute.

The section devoted to the *Transactions* of the **Illuminating Engineering Society** starts on p. 123, with a report of the meeting held on February 20th, when papers on **Shop Lighting by Electricity and Gas** were read respectively by Mr. N. W. Prangnell and Mr. A. E. Broadberry. These are printed *in extenso* (pp. 125–151).

Mr. Prangnell, in his introductory remarks, points out the difficulty of arriving at any standard scheme of shop lighting, even for shops of the same class, owing to the ever-varying local conditions, competition, &c. He also doubts the present feasibility of fixing definitely the illumination required for showing a particular class of goods, and quotes examples showing the great diversity of practice amongst shops, all of which, nevertheless, appear well lighted. In dealing with indirect lighting, the author makes reference to the work of Mr. J. Eck, and also mentions the development now taking place in the use of tungsten indirect units, giving illustrations of some of the most recent designs for these fittings. The adoption of screened lighting for shop windows is dealt with at some length, several diagrams being reproduced in order to show the various methods of lighting from above the window through diffusing glass, or from screened battens, &c.

The lighting of facia boards and the use of special reflector signs for interior lighting is touched upon by the author, the description being again supplemented by diagrams and photographs. A good example of the use of long tubular lamps for the internal lighting of shop windows is shown in a photograph of a picture shop. The author concludes

with a reference to unscreened lighting, and cites a case in which fifty tungsten lamps (30-watt) were used without shade or reflector; but, owing to their nearness to a light ceiling, the effect was good.

In dealing with Shop Lighting by Gas (p. 138), Mr. Broadberry begins by emphasizing the value of good lighting as a means of getting business, and quotes a case in which trade was definitely turned in a particular direction by the brilliant exterior lighting of a row of shops. He also refers to the great advances recently made in gas lighting, especially in the direction of high-pressure lighting, which is coming into extensive use for the exterior lighting of shops. A large number of photographs are reproduced in the paper, showing the application of gas lighting to various classes of business. Mr. Broadberry also comments on the difficulty of standardizing a scheme of lighting for a particular class of shop, showing two shops of the same firm, but in different districts, in which the style of lighting (and window dressing) is markedly different.

The author attaches much importance to the style of window dressing employed, as determining the type of lighting to be adopted, and the illustrations serve to demonstrate this point.

The paper concludes with a series of diagrams and curves showing the variation in the illumination from top to bottom of a window with different types of lamp and different conditions of spacing.

Following these papers will be found an account of the **Annual Dinner of the Illuminating Engineering Society** at the Trocadero Restaurant on February 15th. On this occasion the President, Prof. S. P. Thompson, was in the chair. The toast of "The Illuminating Engineering Society" was proposed by Prof. R. S. Clay, of the Northern Polytechnic. In the course of his speech he laid stress on the international connection of the Society, as illustrated by its Corresponding Members in different parts of the globe, and by the invitations it was constantly receiving to be represented at International Congresses where the subject of illumination was to be discussed. The President, replying, traced the history of the Society from its early stages, laying stress on the cordial relations which had always existed between members of the Council, and acknowledging the valuable services of the present Chairman of Council (Mr. Goodenough). He pointed out the immense change which was being brought about in people's views on lighting matters—largely due to the good work of the Society.

Mr. F. W. Goodenough proposed the toast of "Kindred Societies," and also emphasized the work to be done in connection with other bodies and institutions, especially those concerned with architectural matters. Mr. R. G. Shadbolt (President of the Institution of Gas Engineers) and Mr. W. M. Mordey (Past President of the Institution of Electrical Engineers) replied. Both emphasized the important work the Society was doing — work which could not be done by any other existing institution.

Mr. R. J. Wallis-Jones in proposing the toast of "Our Guests," alluded to the valuable work done by the Educational Department of the L.C.C. and the interest it had recently taken in illumination.

Dr. W. Garnett, Educational Adviser to the London County Council, replying, agreed that this was an age, not only of specialization, but also of co-operation between various experts, and eulogized the work of the Illuminating Engineering Society in this direction; and Dr. F. G. Kenyon (Chief Librarian at the British Museum) expressed his recognition of the need for standardization of methods of lighting in libraries.

In conclusion, Mr. L. Gaster (Hon. Secretary) briefly proposed a vote of thanks to the distinguished President for taking the chair, and expressed the warm appreciation of his services during the infancy of the Society; and the President's health was drunk with enthusiasm.

At the end of the number will be found the usual Trade Notes, the Review of the Technical Press, &c.

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

Illumination as a Study for Architects.

By John Darch, F.S.I.

(*Paper read at the Society of Architects, January* 11*th*, 1912.)

In commencing his paper on the subject Mr. Darch laid stress on the responsibilities of the architect in lighting matters. The average architect, he remarked, is not sufficiently impressed with the importance of good illumination, which is largely left to the empirical methods of the electrical engineer or gas fitter. There is much to admire in the ingenuity and progress shown in the production of light; but the engineer has brought the consumer a good article, and left him to use it, waste it, or do what he likes with it. In considering the use of his light the consumer ought, Mr. Darch suggests, to insist on more assistance from the architect, who occupies an impartial position as regards the different illuminants, and whose own work is closely concerned with æsthetic aspects. It is therefore important for the architect to understand thoroughly the fundamental rules of good illumination.

Mr. Darch then proceeded to deal successively with the physical, physiological, and æsthetic aspects of the subject. He reproduced a table showing the small percentage of energy converted into light by most artificial illuminants. From the physiological standpoint he emphasized the need of: (*a*) Sufficiency of light, (*b*) perfect steadiness, (*c*) effective diffusion, (*d*) freedom from violent contrasts, (*e*) a downward direction — preferably obilque, and (*f*) colour as white as possible. Unfortunately these conditions are almost invariably violated to some degree. The reading-illumination provided in schools sometimes errs on the side of insufficiency. On the other hand, the evil of excess of light, wrongly directed, is shown in the high intrinsic brilliancy of artificial illuminants placed in the line of sight. Provided the eye is screened effectively from this intense brightness and objectionably violent contrasts are avoided (Prof. L. Weber sets the desirable limit at 100 : 1), Mr. Darch declared that he, personally, did not find even 20 foot-candles fatiguing.

Æsthetics are frequently the sole *raison d'être* of an architect's employment; seeing that form and colour are a mental sensation due entirely to illumination, it follows that the character and direction of this illumination is a most important factor. It should be noted—(1) that a white light (and that only) will reveal a complete range of colours; (2) that flat decorated surfaces require a uniform and sufficient illumination, so as to avoid gloss; and (3) that the natural method of exhibiting architectural features and sculpture is by aid of partly diffused downward or oblique light.. The Greek architects well knew that it was upon the lights and shadows that their superb art depended; an architectural feature seen in any other light than that for which it is designed is an abortion. Yet this point is often entirely lost sight of in important public buildings. The advice of an architect who could so

illuminate an important building as to display clearly and readily its true character and full beauty would be very valuable.

In the same way the design of fixtures for old interiors but for use with modern illuminants is a difficult problem; the cumbrous relics of the past are still used with twentieth-century lights engrafted thereon, and in most cases massive fixtures having an obstructive effect are best avoided.

Proceeding to general principles, Mr. Darch suggested a series of rules of good lighting.

The whole case for good lighting is embodied in a very simple axiom, viz.: *The purpose of artificial lighting is to make readily and properly visible the things required to be seen.*

This may be made more definitive by the following rules :—

1. The lamps or other sources of light to be so disposed that they do not occupy the field of vision.

2. The illumination to be sufficient to cause the objects to appeal at once and with comfort to the eye.

3. For general illumination the light to be well diffused, with a preponderating downward direction, freely flooding ceilings and walls.

4. Local lighting of desks, benches, exhibits, &c., to be specially suitable and in most cases adjustable in position and power.

5. The colour to be as pure and white as possible. Light of peculiar colour as a rule, to be avoided.

These rules must be strictly adhered to. Curiously enough, some of our illumination reformers have advocated similar principles and straightway broken them in their next job.

A false light makes a false impression, and an interior, no less than a face, can only be its own self when naturally presented. It requires nothing more than common-sense, and a consideration of the natural demands of any object to be illuminated, in order to produce truthful and agreeable results.

Turning next to the question of the relative merits of general and local lighting, Mr. Darch pointed out that both methods have their respective fields of utility. A further subdivision of general lighting may be made into direct and indirect. When the so-called direct system is used, particular care must be exercised to ensure that the lights are screened from the eyes by effective shading. This implies the use of opaque or semi-opaque shades, so as either to conceal the actual source completely or to tone down its brilliancy to some agreeably low value. The shape and position of such shades can be schemed out, so that the light never or rarely falls within the line of vision, and yet is allowed to escape unobstructed into the greater part of the room. One can also avoid any unpleasant shadow-contrasts on the walls or ceilings.

In referring to indirect lighting from a white ceiling or other suitable light-tinted surface, Mr. Darch mentioned the impression that it produces a "flat" and shadowless effect but he did not agree that this was so, and he showed some photographs taken by Mr. T. E. Ritchie, of the Union Electric Co., demonstrating that the effect of light and shade by indirect arc lighting was very similar to that prevailing by daylight.

Mr. Darch next referred briefly to the value of simple instruments for measuring illumination, instancing the following cases in which such instruments would prove of great utility to the architect :—

Case 1.—In giving instructions for a lighting installation the architect may, and should, specify in foot-candles the actual illumination he wants on desks, walls, or working surfaces, and with such an instrument he can see that he gets it. The present procedure is for the engineer to provide him with a schedule of lamps which affords him no information.

Case 2.—In preparing reports of premises it will provide the architect with definite data.

Case 3.—In ancient light cases the rule of thumb methods of determining amounts of light that creates such contradictory expert evidence can now give place to indisputable fact.

Case 4.—In rendering legislation intelligible. At present the Factory Act

Regulations of 1908, require that certain rooms be "efficiently" lighted, an expression that is better adapted to bewilder a magistrate than to be of service to any building. Had those regulations required a minimum illumination of 1 ft. candle or otherwise, the illuminometer would have placed the matter beyond dispute.

In this connexion Mr. Darch presented a series of effective drawings, some of which have been shown in previous contributions and papers, and referred to in this journal.*

The question of units and definitions of quantities used in illuminating engineering was one that was receiving the active attention of the Illuminating Engineering Societies in Great Britain and the United States.

One other matter of considerable moment to architects and those concerned with decorative aspects of illumination was the amount of light reflected from wall papers. He presented a table of values published by Dr. L. Bell, and suggested that sheets of wall paper should have their coefficient of reflection marked on the back.

In the last section of his paper Mr. Darch summarized the practical applications of the foregoing to churches, schools, libraries, &c. He spoke with special favour of the method of illumination in the Guards' Chapel, St. James's Park, and advocated the use of special local lighting for the pulpit and reading desk (which should receive 4 foot-candles), and for notices and inscriptions. School lighting, in his experience, was often deficient in quantity or too uneven, the black-board being often neglected; another common defect was the exhibition of unprotected lights in the range of vision of scholars and teachers. In connexion with hospitals, Mr. Darch summarized the suggestions made in his paper at the Annual Congress of the Royal Sanitary Institute last year,† and subsequently made some pertinent remarks on library and workshop lighting. The paper concluded with an appendix in which a series of definitions of the chief terms used in connexion with illumination was given.

The subject was then thrown open for discussion.

Mr. Freyburg proposed a vote of thanks to the lecturer. He questioned if readers could be trusted to switch off their own light. As to schools, he remembered how badly they were lit in his own school days.

Mr. Tucker, in seconding the vote, said that architects had to consider the question of cost, and there was little room for special lighting. Light diminished in inverse ratio to the square of its distance, so that in lighting a room by reflection much would be lost.

Mr. Justus Eck regretted that Mr. Darch had not referred to daylight illumination; the importance of artificial lighting being as similar as possible to daylight, had not been sufficiently impressed.

Mr. V. H. Mackinney pointed out some of the differences between the effect of daylight and artificial illumination. He thought the appendix would be valuable to engineers, but did not entirely agree with some of the definitions. He thought that the architect could often derive valuable and disinterested advice even from engineers concerned mainly with one branch of lighting.

Mr. J. S. Dow explained that Mr. Gaster had been unavoidably, and to his regret, prevented from being present. He welcomed the views of architects upon illumination. There were many instances where an architect required special arrangement of lights on account of the architectural features of the building which would be governed by different factors to those usually employed by engineers.

The Chairman, commenting on the value and importance of the paper, put the motions to the meeting, which were carried unanimously.

Mr. Darch, in reply, said the architect held the key of the situation, and his influence would probably go further than that of any other person. Reformers should, therefore, spread the

* See 'The Art of Shading,' vol. ii., 1909, pp. 83, 173.

† *Illum. Eng.*, Lond., vol. iv., 1911, p. 521.

gospel of illumination amongst architects. In reply to Mr. Tucker, he thought that, light for light and effect for effect, indirect lighting might be cheaper than direct. As to loss of light, the law of inverse squares applied only to light from a point, but from a ceiling that equalled the area of the floor, there would be little lost, but depending of course on the room. In reply to Mr. Eck he thought he (the speaker) had very fully pointed out that daylight conditions should be those of artificial lighting, and he agreed that those conditions were well met in indirect lighting from a large white ceiling illuminated by good steady carbon arc lamps. He did not consider that artificial lighting, however high the candle-power, meant concentrated light and dark surroundings; the very object of this lecture was to condemn that sort of thing, and to point out a better way.

The Royal Sanitary Institute.

Henry Saxon Snell Prize.

An interesting announcement has been made by the Royal Sanitary Institute that the Henry Saxon Snell prize of 50 guineas, and the silver medal of the Institute, which is awarded at intervals of three years, is this year to be offered for an essay on The Ventilation, Lighting, Heating, Water Supply Appliances, and Fittings of an Operating Room in a General Hospital.

Full particulars regarding the competition can be obtained from The Secretary, the Royal Sanitary Institute, 90, Buckingham Palace Road, London, S.W.

Annual Dinner of the General Electrical Company.

The Annual Dinner of the General Electric Company is always an interesting event, and the proceedings at the Trocadero Restaurant on Saturday, February 10th, proved no exception. A number of distinguished guests, including Sir George Houstoun Reid (High Commissioner for Australia), the Hon. Sir William Hall Jones (High Commissioner for New Zealand), Sir Edward Holden, Prof. John Perry, and many others spoke during the evening, and nearly 600 guests in all were present.

Mr. H. Hirst, who presided, in proposing the toast of the evening on "Engineering Science and Industry," laid special stress on the value of training and education, and most of the subsequent speeches bore on this point. Mr. Hirst emphasized the difficulty of securing men with an adequate training and a sufficiently wide outlook to fill important engineering and commercial posts. He said that industry demanded more men from the public schools and universities, asking, "Can any one recall an instance of victory resting with an army which has not been led by the best brains and the best blood of its country?" In the course of his speech, Mr. Hirst also alluded to the death during the past year of Mr. G. Byng, to whose organizing capacity and foresight so much of the success of the General Electric Co. was due.

In the course of the evening Prof. Perry criticized in a forcible manner our existing methods of education; and Sir Edward Holden quoted instances to show that much could be done by proper encouragement of study on the part of the firm itself.

Whatever views held as to the ideal educational methods or the class of men from which it was most desirable that commercial men and engineers should be drawn, there was, however, agreement on one point—that engineering and commerce at the present day demand specialization, wide knowledge, and training of an entirely different kind from what sufficed in the past.

Electric Lighting of Streets having Permanent Verandahs.

By E. Kilburn Scott, M.Inst.E.E.

In some parts of the empire as well as in some foreign countries the principal city streets have wide permanent verandahs built over the whole of the footpath. For example to go no farther than Paris, one of the main streets has such a continuous verandah, and in some of the cities of Southern Europe such verandahs are commonly met with. In Australian cities also some of the principal streets have the footpath covered in, as no doubt have other cities of the empire where the sun *does* shine longer than in England.

Some of the light passes out from the verandah and assists to light the roadway, but generally the streets are lighted by arc lamps down the centre as in B Fig. 1.

Sydney being an older city has narrower streets than Melbourne so that arcs in the middle have a better chance of lighting under the verandahs. Formerly the arcs in George Street, which is the main artery, were supported on posts, but there were many accidents from people colliding with the posts when jumping off cars, &c.,

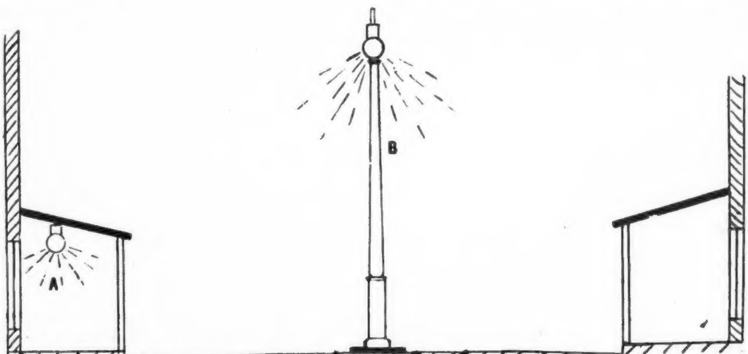


Fig. 1.—Showing general and local illumination of a street with a verandah.

so the arcs are now suspended. Of course people can get accustomed to anything, and so the suspension wires are not noticed after a time, but they are really more unsightly than trolley wires. They sag badly, are across the line of sight as one walks along a street, and they are liable to be very much in the way in case of fires.

The lighting of such streets is obviously more difficult than where the street is open, for lamps along the kerbs are too far away to light under the opposite verandah, and obviously they are of no use for the side they are on. Even lamps down the middle of the street cannot light under the verandahs effectively.

In Melbourne, numbers of flame arc lamps are fixed under the verandahs as shown at A in Fig. 1, and as may be imagined the effect is very glaring. It is painful for those with weak eyes, and such people are numerous in these days of newspapers, small print bibles, cinematograph shows, &c.

It has been frequently pointed out that lighting by means of great units of light at infrequent intervals as in the case of arcs, is unsatisfactory. Therefore there is now a distinct tendency towards greater subdivision of light in streets. The introduction of the metallic filament lamp and re-

flectors which spread the light have made this possible, and Mr. Haydn T. Harrison's very useful paper showed conclusively that street lighting by metallic filament lamps is now a commercial proposition.

In this connexion it may be of interest to quote a letter which Mr. R. P. Brousson of the Great Northern and City Railway Company, has sent to the writer. He says, "We have been making experiments over a considerable period with metal filament lamps versus enclosed type direct current arc lamps for the lighting of our tube stations. The result is that we have come to the definite conclusion that the lighting obtained from five arc lamps, taking 6 amperes in series, on 550 volts and spaced 50 feet apart does not give such a good illumination as that obtained from ten 200 c.-p. one watt metal filament lamps spaced equally apart over

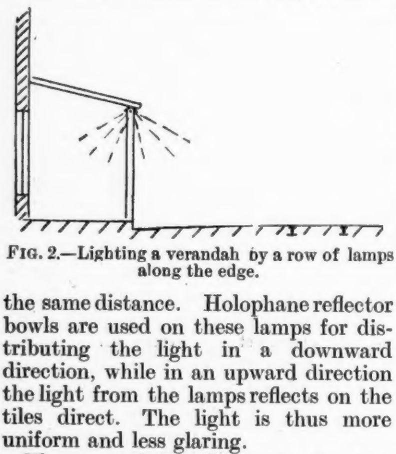


FIG. 2.—Lighting a verandah by a row of lamps along the edge.

the same distance. Holophane reflector bowls are used on these lamps for distributing the light in a downward direction, while in an upward direction the light from the lamps reflects on the tiles direct. The light is thus more uniform and less glaring.

The cost of installation in the two cases is the same, and there is very little difference in the cost of maintenance, but if anything, the metal filament lamps cost less to maintain than arc lamps. The life of the metal filament lamps is 5,000 hours. Of course if we had to buy our electric power for lighting from an outside source, there would be a considerable economy with metal filament lamps. The maintenance for the two systems over a period of 5,000 hours is £65 and £55 including the cost of current."

It is true that arc lamps of small candle power are made, but they cost nearly as much as full-sized arc lamps because they have practically the same mechanism. The carbons are also somewhat fragile, and generally it may be fairly stated that the small arc lamp is not a commercial proposition so far as street lighting is concerned.*

The writer considers that the best way to light verandahs is by means of metallic filament lamps. If they can be placed so as to not only light under the verandahs, but the roadway as well then so much the better. This would be possible by arranging a row of lamps along the edge of the verandah as shown in Fig. 2. It would have the advantage of leaving the street quite free of posts, span wires &c., whilst giving that effective lighting under the verandah which is desirable. There is an objection to using ordinary incandescent lamps, namely the vertical height taken up, and the number of points or outlets that would require to be wired. The writer suggests therefore that the long tubular incandescent lamps, &c., lend themselves exceedingly well to this proposed system. They are usually made up in lengths of 3 ft. 4 in. each containing four lamps, but they could be made longer. The number of wiring points or outlets would be much reduced over what would be necessary with ordinary lamps. At the same time as the lamps are only $1\frac{1}{2}$ in. in diameter, they and the reflectors could be easily fixed to the verandah, and if placed a few inches back from the edge they would be out of the rain.

The following is a rough estimate for lighting half a mile of street with the fittings known as Tubolite, each length 3 ft. 4 in. long. Allowing 10 feet between them, that is 13·3 ft. centres. In half a mile $\frac{2640}{13\cdot 3} = 198$ lengths would be required, and the total length of fittings would be $198 \times 3\cdot 3 = 660$ ft. At 10*s.* a foot run say £330. There would be 198 wiring points or outlets and 5*s.* a point should be ample to cover cable,

* It is interesting to note that small arc lamps are used for lighting under the verandah of the Opera House in Kingsway.

tubing, connecting to street mains, sundries, and labour, say another £50. This is not out of the way as regards capital cost when compared with Mr. Haydn Harrison's figures, but even so the extra cost is justified by the fact that underneath the verandahs would be effectively lighted.

The appearance of a street having its verandahs fitted with lines of incandescent lamps as suggested would be very fine.

Lectures on Illuminating Engineering.

DURING the past month one of the three courses of lectures on illuminating engineering now taking place in London has been concluded—that at Regent Street Polytechnic. The attendance and interest shown have been most gratifying, and it may be hoped that this successful precedent will lead to the establishment of other more complete courses of this description in the future. The lectures at University College and the Northampton Institute are still proceeding, but will be concluded during this month.

RADIATION AND PHOTOMETRY.

At University College Prof. Clinton's lectures have dealt mainly with photometry and radiation. Lecture IV. dealt with the 'Production of Light.' Prof. Clinton explained, by aid of diagrams, the chief laws of radiation, showing how, as the temperature of incandescence of a "black body" was increased, the percentage of visible energy generated was raised and a more efficient illuminant obtained. Subsequently he showed how, by utilizing selective radiation, another possible means of improving luminous efficiency was at hand. Luminous solids, gases, and flames gave rise to quite distinct qualities of radiation (sometimes quite divergent from daylight), according to the degree to which selective radiation was present. In conclusion, tables showing the luminous efficiency of various illuminants were presented.

In Lecture V. the fundamental principles of photometry were discussed. The lecturer explained the nature of the inverse square law and cosine law, and their limitations, the use of the rotating sector, and the ordinary operations carried out on a photometric bench. He discussed at some length the order of sensitiveness and accuracy attainable, pointing out how this was affected by the intensity of illumination on the photometer-screen. An experiment was also shown illustrating the difficulty of matching lights of different colours. The two sides of a large white wedge facing the audience were illuminated respectively by red and green light. It was shown that if the distance of both sources from the wedge was doubled, the two sides no longer appeared equally bright, the green being now the more luminous of the two; this, the lecturer explained, was a physiological phenomenon—the Purkinje effect.

The lecturer then passed on to standards of light, the Harcourt Pentane, Hefner, and large-bulb Fleming incandescent standards being shown. In the subsequent lecture he passed on to photometers, showing quite a variety of different types, including the Ritchie wedge, the Joly Block, the Bunsen, Lummer-Brodhun, &c. An interesting means of demonstrating the action of flicker photometers was also employed, the beam from a lantern being separated into two, coloured respectively red and green, which were re-combined on the screen. By a rotating sector device the red and green were extinguished alternately, and the action of the flicker photometer imitated. Descriptions of a number of different methods of obtaining polar curves of light-distribution of sources were also given.

The seventh lecture, on February 21st, commenced with a brief descrip-

tion of various illumination photometers, the Trotter, Harrison, and Holophane Lumeter types being exhibited and explained. The second portion of the lecture was devoted to an explanation of the chief photometric quantities, the calculation of mean spherical candle-power, and the use of the conception of luminous flux in illuminating engineering problems. Prof. Clinton also threw on the screen a series of distribution curves obtained with a great variety of shades and reflectors, showing how the light could be usefully directed in various directions, according to the nature of the local circumstances. At the conclusion the lecturer and audience sallied forth into the quadrangle to make measurements of illumination and to demonstrate the practical working of the various illumination-photometers shown.

The Colour Effects of Illuminants.

At the Regent Street Polytechnic, on February 1st, Mr. J. S. Dow dealt with the colour of artificial illuminants. He explained the distinction between the qualities of light emitted by incandescent solid and gaseous illuminants, and pointed out the waste in the production of non-visible heat energy which occurred. If we were able to produce white light, and no extraneous invisible radiation, it was calculated that an efficiency of about 26 c.-p. per watt might be obtained; as much as 60 c.-p. per watt might, however, be obtained if one could produce only the highly luminous yellow-green rays.

Passing on to the effect of light on coloured objects, the lecturer showed some experiments illustrating the enormous colour-distortion which might be caused by illumination with pure red, green, or blue light. Such effects were present (to a smaller degree) in the case of artificial illuminants whose spectrum differed from that of daylight. This naturally led to a brief explanation of Mr. Ritchie's recent researches, some slides kindly lent by him for the purpose being shown; and Mr. Dow also explained the Mees daylight unit, which, by the courtesy of Benjamin Electric, Ltd., he had an opportunity of exhibiting. A series of colour-boxes lent from the Holophane laboratory were also shown.

Subsequently some possible uses of monochromatic light were referred to—*e.g.*, for lighthouses, for revealing detail (as contrasted with creating brightness), and for certain physiological effects. Reference was also made to the decorative effects secured at the Allegheny Soldiers' Memorial at Pittsburgh, a series of interesting slides showing this installation (prepared by Mr. T. E. Ritchie) being thrown on the screen. As an example of the peculiarities of colour vision, two large sheets of red and blue paper were illuminated, and their brightness gradually reduced by extinguishing the lamps in the lecture theatre. It was shown how the red, originally the brighter of the two, ultimately became the darker, and that at a very dim illumination the colours became indistinguishable, the red appearing dead-black and the blue white.

In conclusion, the lecturer referred briefly to the ultra-violet rays, and described their uses for sterilization, testing the permanency of dyes, &c. An experiment was shown illustrating their existence beyond the visible spectrum, as revealed by a fluorescent screen, and the action of the rhodamine reflector for the mercury lamp, kindly lent by the British Westinghouse Cooper-Hewitt Co., was shown to the audience. The action of the Euphos and Spectros glass in stopping these ultra-violet rays was also illustrated.

Practical Lighting Problems.

The last two lectures of the course dealt mainly with practical problems. On February 8th attention was given to daylight, the extreme variation of natural illumination with different kinds of rooms and various climatic conditions being pointed out, and the existing rules for window space discussed. The lecturer then passed on to calculations for artificial lighting installations, suggesting the rough rule that in premises well lighted by low-pressure incandescent gas one might

allow 1 cubic foot of gas per foot-candle per 100 square feet of floor area illuminated. In Holophane installations, and with indirect arc lighting, the corresponding rule might be 25 watts per foot-candle per 100 square feet of floor area illuminated. Naturally, such data were very approximate. The concluding portion of the lecture was given up to school lighting, some of the data presented before the Illuminating Engineering Society being given, and a series of slides lent by the Union Electric Co. and the Gas Light and Coke Co. shown.

At the conclusion of the lecture Mr. Leon Gaster said a few words, expressing his appreciation at the support the course had received, and expressing his regret that he would not be able to be present at the last lecture on Febuary 15th on account of the annual dinner of the Illuminating Engineering Society.

On February 15th the lecturer began with a brief recapitulation of the main points dealt with previously, and then passed on to a brief review of various practical problems. The lighting of private houses, libraries, shops, workshops, and streets was touched on in turn, the remarks being illustrated by an excellent series of slides. Some of these had been prepared by the lecturer for past meetings of the Illuminating Engineering Society ; others were lent by the Union Electric Co and the Gas Light and Coke Co., showing respectively examples of lighting by inverted arcs and incandescent gas. There was also a special series, kindly furnished by the British Thomson-Houston Co., dealing with their " Eye-Rest " system of indirect tungsten lighting.

In conclusion, Mr. Dow thanked those present for their close attention throughout the course, and expressed his indebtedness to the various firms who had contributed to the success of the lectures by lending lantern slides and apparatus. He also alluded to the benefit to be derived from meetings of the Illuminating Engineering Society, which he advised those present to join. He hoped that courses of illuminating engineering would soon become a regular feature, and that in the future he might have an opportunity of dealing with some of these points in greater detail.

Electric Lighting, Chemistry of Gas, Shades, and Reflectors.

On Tuesday, February 6th, Prof. Denton delivered his second lecture on 'Electric Illuminants,' at the Northampton Institute. Besides referring to the lamps themselves, electric distribution problems were touched upon, and the distinction between continuous and alternating supply, constant current and constant P.D., &c., explained.

The next lecture on the list, by Mr. S. Field, was devoted to the chemistry of coal-gas manufacture and lighting. Problems in generation, purification, &c., at the gas works occupied the first part of the discourse, and the final portion dealt with the principles underlying combustion.

Mr. S. D. Chalmers, on February 20th, explained the fundamental laws of reflection, the distinction between mat and polished surfaces, &c. He then passed on to the design of reflectors for special purposes, such as the Holophane prismatic reflectors, and also said something on the subject of prismatic glass for use in windows, with a view to improving the distribution of daylight. He also touched upon the conversion of light by phosphorescence and fluorescent screens.

Feb. 27th was allotted to a lecture on 'Physiological Factors,' by Dr. W. Ettles, whose previous discourses at Regent Street and Battersea Polytechnic we have already dealt with.

The three concluding lectures of the course are as follows :—

March 5th. 'The Practical Use of Arc Lamps,' by Mr. J. S. Plumtree.

March 12th. 'The Practical Use of Metallic Filament Glow Lamps,' by Mr. V. H. Mackinney.

March 19th. 'The Practical Use of Gas Lamps,' by Mr. F. W. Goodenough.

These should be of exceptional interest to members of the Illuminating Engineering Society (with which, it is interesting to note, the lecturers are all associated).

Indirect Lighting by Tungsten Lamps.

THE present-day tendency towards eliminating glare and harsh shadows in interior lighting is indicated by the increasing number of installations on the indirect system which can be seen in London and elsewhere. We have previously referred in these columns to indirect lighting by arc lamps, and several examples have been given. The accompanying illustration—a reproduction of an untouched photograph taken entirely by artificial light—shows an installation of indirect tungsten units in the board room at the London offices of the British Thomson Houston Company. This room is lighted by two bowl fittings, each containing four 80-watt lamps equipped with X-ray reflectors. The intensity of illumination thus obtained at table height is 3 foot-candles, and the variation over the whole area is said not to exceed one-tenth of a foot-candle. The general effect of the illumination is very restful, and in revealing light and shade it is considered to approximate very closely to daylight.

The Lighting of a Board Room by Indirect Tungsten Units.

Coming Gas Exhibition in Amsterdam.

WE notice that it is proposed to hold an International Gas Exhibition in Amsterdam. Progress in gas lighting has been so rapid during the past few years that an exhibition of this kind should be of absorbing interest. We understand that a special feature will be the demonstration of the industrial and domestic applications of gas, and that papers bearing on these subjects will also be read.

It is proposed that the exhibition will be held in the Industrial Palace in Amsterdam, and that it will be open from September 14th to October 6th. Those interested should communicate with Heer van Rossum du Chattel, Municipal Gas Works, 29A Amstel, Amsterdam.

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

(The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.)

Shop Lighting.

(Proceedings at a meeting of the Illuminating Engineering Society held in the House of the Royal Society of Arts (London), on Tuesday, February 20th, 1912.)

A MEETING of the Society was held on February 20th, 1912, MR. F. W. GOODENOUGH (Chairman of Council) being in the chair.

The minutes of the last meeting having been taken as read, the Chairman called upon the HON. SECRETARY to read again the names of applicants for membership presented at the previous meeting*, who were then formally declared members of the Society. The names of applicants for membership received since the last meeting were also read out for the first time.

THE CHAIRMAN then called upon MR. N. W. PRANGNELL (Metropolitan Electric Supply Co.) to open the discussion by reading his paper on 'Shop Lighting by Electricity.' This was followed by a paper by MR. A. E. BROADBERRY (Tottenham Gas Co.) on 'Shop Lighting by Gas.' (These papers will be found *in extenso* on p. 125.)

THE CHAIRMAN, before declaring the subject open for general discussion, congratulated the authors of the papers on the amicable spirit in which they had treated their subject. He thought that it was difficult to lay down any general rules, even for the lighting of a particular class of shop, owing to the very varied conditions of street, locality, &c. He was glad to see screened lighting coming into more general use.

MR. HADYN HARRISON suggested stage lighting as a good pattern of what shop lighting ought to be, but pointed out certain difficulties, such as the way in which persons usually stood too close to the window to get the full effect of the lighting. He insisted that the object of shop lighting must be to sell goods, and gave an instance in which an illuminant of unusual colour affected sales adversely, and had to be changed. With regard to the lack of uniformity in the lighting of shop windows, he thought more should be done in the way of batten lighting, using lamps at the bottom as well as the top of the window.

MR. R. J. WALLIS-JONES referred to the general tendency towards increased illumination, which was very noticeable in shop lighting. He considered that indirect arc lighting had a somewhat depressing effect. He agreed with Mr. Harrison that the stage formed a good model for shop window lighting, and described the special reflectors which he had installed for the lighting of Messrs. Selfridge's windows. The intensity of outside lighting was frequently exceedingly great, and the values indicated in the papers were in many cases considerably higher than those suggested in a recent table appearing in *The Illuminating Engineer*.

MR. WOODALL briefly expressed his pleasure in being present at a meeting where the common interests of gas and electrical engineers were discussed in such a friendly spirit.

MR. R. G. SHADBOLT (President of the Institution of Gas Engineers) said that a good deal of importance should be attached to the personal factor—different persons were satisfied with very different intensities of light. In many localities the effect of improved street lighting had been seen in the greatly increased illumination of shops. He was inclined to ask whether the maximum permissible intensity had not been overstepped in many cases.

MR. F. W. WILLCOX thought that far greater uniformity should be aimed at in shop lighting, and mentioned some

* See *Illum. Eng.*, Lond., Feb., 1912, p. 63.

reasons why, in the average shop window, it was difficult to get effective lighting. He suggested three important factors, viz., the height of the lamps, the spacing of the lamps, and their equipment. The shallowness of many shop windows made outside lighting imperative, but in this matter, as well as in the dressing of windows, there was need for education of the shopkeeper. Mr. Willcox mentioned a case in America, in which good lighting proved sufficiently attractive to draw customers away from the main street of shops into a comparatively little-frequented district.

MR. A. H. RICHARDSON called attention to the fact that, although there was very great variation in the values of illumination given in the paper for different shops, they were all quoted as *good* examples, and he thought, perhaps, too much stress was being laid on the question of uniformity. He suggested that a series of tests carried out by the Illuminating Engineering Society as to the height and spacing of lamps for shop lighting would be of considerable value.

MR. J. ECK was glad that Mr. Broadberry had advocated the use of lamps giving a light as nearly approaching daylight as possible. He exhibited a model shop-window lighted by arc lamps contained in a space above the window, and shining through diffusing glass.

MR. W. E. BUSH described some slides showing examples of shop-lighting by tungsten lamps, both on the direct and indirect systems.

MR. L. GASTER spoke on the subject of effective window dressing, and insisted that a shop window should only exhibit samples of what might be purchased inside, and should deal especially with the latest goods on the market. He also referred to an exhibition of shop lighting in Berlin, a year or two ago, in which some very beautiful effects were obtained at a cost which was limited by the rules to a certain amount.

At the conclusion of the discussion, the Chairman announced that the authors would prefer to communicate their replies for insertion in the *Proceedings*, and a hearty vote of thanks was then accorded to them, the motion being carried with acclamation.

The next meeting was announced to take place on MARCH 19TH, when papers would be read on the 'LIGHTING OF PRINTING OFFICES,' by MR. JUSTUS ECK and MR. F. W. GOODENOUGH.

Official Notice of Next Meeting.

The next meeting of the Illuminating Engineering Society will take place at 8 o'clock at the House of the Royal Society of Arts (John Street, Adelphi, London, W.C.) on **Tuesday, March 19th, 1912,** when papers on the **Lighting of Printing Offices** will be read by **Mr. F. W. Goodenough** (Gas Light and Coke Company) and **Mr. Justus Eck** (Union Electric Company).

Lecture on Illumination at the Society of Arts.

ON Wednesday, March 6th, a paper will be read by T. Thorne Baker on 'Some Modern Problems of Illumination: the Measurement and Comparison of Light Sources.' The chair will be taken at 8 o'clock by James Swinburne, F.R.S., Past-President of the Institution of Electrical Engineers.

Shop Lighting by Electricity.

BY N. W. PRANGNELL, A.M.I.E.E. (*Metropolitan Electric Supply Co.*)

(Paper presented at a meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts, John St., Adelphi, London, on Tuesday, Feb. 20th, at 8 P.M.)

THE present is a most opportune time for this and all artificial lighting problems to be brought forward and discussed by our Society. I say this because I think that we must all have recognized that the tendency at the present time is to give more attention to the many problems involved, and it is very necessary to encourage this tendency.

From an illuminating engineer's point of view, the questions involved in dealing with the artificial illumination of business premises where goods have to be exhibited for inspection and sale are far more intricate than others they may meet with. The factors which have to be taken into consideration before a scheme can be decided upon are many and varied. The

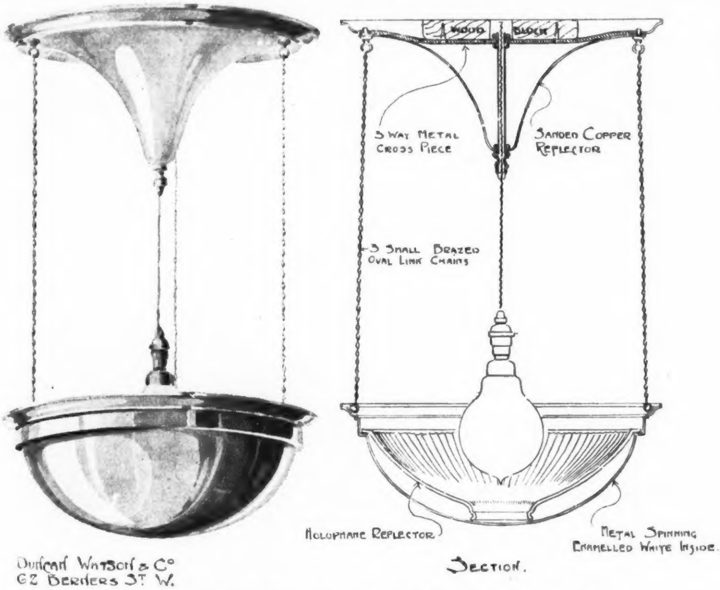


FIG. 1.—Design for Indirect Lighting Fixture, using Tungsten lamps.

The introduction during recent years of the several new forms of illuminants, with their extremely high intrinsic brilliancy and greatly improved efficiency, has practically forced all of us concerned with the subject to scheme how best to apply the new conditions. When we remember the great number and types of new fittings and reflectors that have been brought into use within the last two years, I think it will be agreed that some very useful work has been done.

subject is a very extensive one and difficult to condense into the few practical remarks which I wish to make for the purpose of introducing it from the electrical side, with the object of laying the foundation for a useful discussion by our Society. My remarks are intended to apply only to illumination for the purpose of showing goods, and not for advertising.

A member recently suggested that he thought the time had now arrived when it was possible to say definitely that

a given scheme could be made a standard for similar types of business. In my humble opinion the time for being able to do this is very distant. If you enumerate the types of business, you can easily carry the numbers into three figures, and each can, and must, be again divided under a series of headings, such as 'Class of Business,' 'Local Conditions and Competition,' 'Size and Shape of Premises,' 'Class of Goods to be Shown,' 'Electric Supply Available,' &c., all of which make any effort to classify very difficult. With a view to illustrating my point, I would tell you of a butcher friend of mine who has a large number of retail shops in London and the provinces. He sells one class of meat only, and considering how simple a form of shop a butcher requires, you would surmise that the conditions were ideal for a uniform scheme for all his electrically lighted premises. This was not found to be possible, and with forty shops it has been necessary to adopt nine different schemes. In one district, owing to the rival butcher using special flame arcs, it was thought advisable to adopt the "Batten" system, by which I mean a row of tungsten lamps fixed to long lengths of pipe across the front of the premises, each lamp being provided with a small enamelled iron shade, so arranged that the light was concentrated on to the meat. With this system his salesmen were able to cry his goods as not requiring a red glare to give an unnatural colour to his meat. In another district the conditions were reversed, and my friend had to adopt flame arcs, and no doubt his men shout about the healthy glow of their meat. These instances will be found to apply in a more or less degree to practically all types of business.

FIG. 1A.—General view of the "Adnil" indirect tungsten unit.

My experience has also shown me that it is not feasible to set a standard of measurement of light as being required for showing a particular type of goods. This may be a drastic statement to make before so many experts, and I trust that in the discussion some members may be able to make useful reference to the point.

In some recent tests made in nine jewellers' shops, all of which are employing fairly modern methods for their lighting, the illumination was found to vary from 6 to 15 foot-candles, and in six general drapery premises from 2 to 8 foot-candles. In each case the proprietors expressed themselves as quite satisfied with the amount of illumination at their disposal, and thought it neither too much nor too little. All these tests refer to interior illumination taken over the counters, and not to window lighting.

On the question of colour the difficulties and remedies have been so well put to us in the extremely valuable paper recently given by Mr. T. E. Ritchie that I do not intend to say very much about it, except that, for all practical and commercial purposes, the results to be obtained by the use of tungsten lamps can be made quite satisfactory. The use of coloured screens has been tried in one or two instances in which I have been interested during recent years, but the conditions have had to be very special indeed before it was thought necessary to resort to this method in order to gain the end desired.

The matching of articles certainly calls for a correctly coloured light, but for the sale of goods—when it is remembered that they have almost for certain to be used in all kinds and conditions of lights—I rather contend that the point is not such an important one.

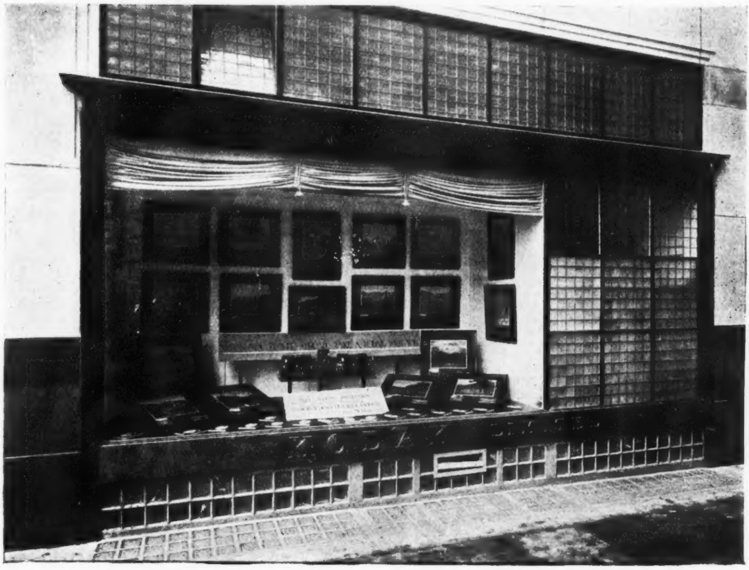


FIG. 2.—View of Kodak Company's premises in Kingsway, showing shop-window by daylight.

FIG. 3.—View of interior of above premises by daylight.

It is usual to classify lighting schemes under the heading of 'Direct' or 'Indirect' lighting. On the indirect method I wish, firstly, to draw your attention to the very able series of articles at present being issued in *Electrical Industries*, from the pen of Mr. Justus Eck. Mr. Eck seems to have given this method of illumination, by the employment of arc lamps, his keenest attention. We must certainly compliment him on the many successful installations he has described, and trust that he will be able to give our Society still more information. I have been interested in several installations where this method has been employed, and the results have in some cases been quite successful.

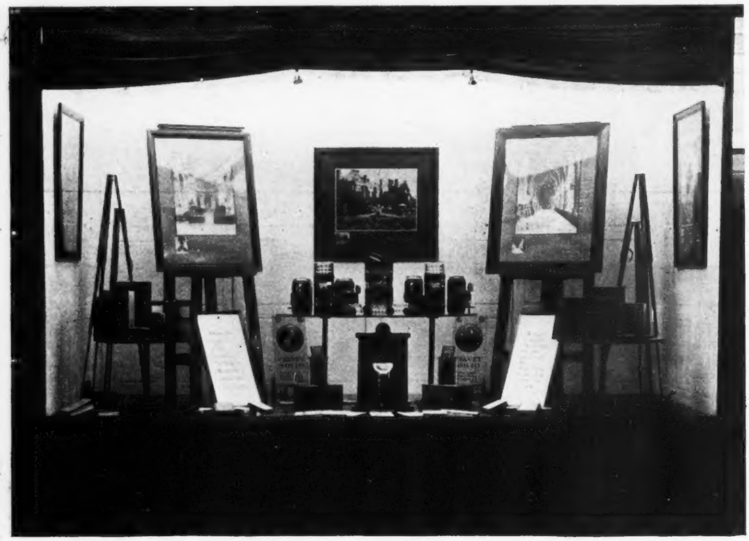


FIG. 4.—View of one of the windows of the Kodak Company taken at night.

A scheme in which a few large lighting units only are employed must suffer very materially should any one of these units fail. I therefore advocate that as great a number of separate lamps as possible should be used. This, to my mind, is more important when arcs are employed than with any other form of lamps. Indirect lighting by the employment of tungsten lamps is now being extensively taken up, and I believe that the success of future lighting will be largely centred around this method. It will be understood that indirect lighting must be handicapped by the necessary greater consumption of current for a given result, but this lower efficiency may be outweighed by such advantages as better distribution, absence of glare, and, possibly, more handsome fittings. Fittings for indirect lighting by tungsten lamps are now being developed by several firms, and Fig. 1 shows a good design recently produced. It will be seen that there is a circular frame of metal or wood, and into this is first fixed a metal bowl which is white enamelled on the inside. Within this bowl is placed a correctly designed glass prismatic or silvered reflector; the single or multi-holder fitting to take the tungsten lamps is suspended above, and adjusted so that the lamp or lamps may be correctly focussed. By this method the inner bowl can easily be removed for cleaning purposes. With any inverted scheme this latter is a very important point, as it is

necessary to be able to remove the reflector without interfering with the lamps.

I will now pass to the direct method of lighting, and for the purpose of describing the several schemes to which I wish to draw your attention I will classify them under the headings of 'Screened' and 'Unscreened.' By screened I refer to methods where the illuminants are so placed that they are to a great degree hidden from the observers' eyes. Fig. 1a gives a very good idea of what I mean by screened. This fitting is on somewhat similar lines to Fig. 1, but for the lower reflector opaque glass is used, thus allowing part only of the light to be reflected. It will have been noticed that during the past year this method, more especially for window lighting, has been adopted with great success by quite a number of our best West End shops. This has resulted in extremely good illumination, and has also in many cases reduced the amount of current consumed.

The first scheme to which I wish to draw your attention is the installation recently put in at the Kodak Company's premises in Kingsway. Fig. 2 shows the general view of the premises by day; Fig. 3 the interior of the shop by day; Fig. 4 is a photo taken at night of one of the windows. This latter photo does not give justice to the illumination, because it was not found possible to screen the light from the several street lamps and buildings near by. It will be plainly seen that the shadows cast by the easels must be due to some outside source of light.

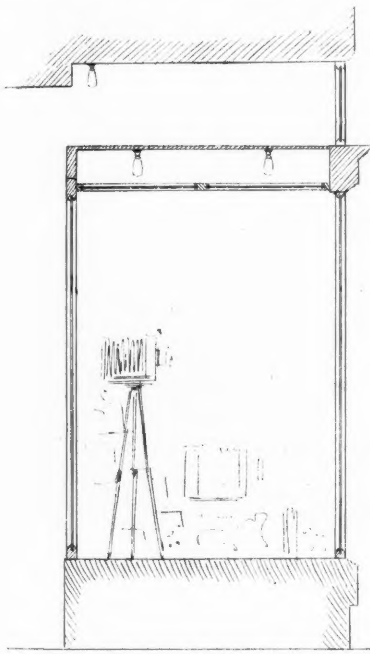


FIG. 5.—Showing method of obtaining the even illumination in Fig. 4.

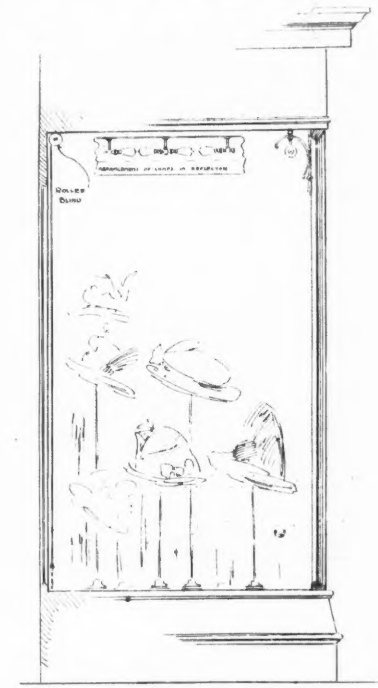


FIG. 6.—Showing trough reflector in use at Messrs. Selfridge's......also roller blind at back of window.

The sketch Fig. 5 shows the method employed to obtain the even and shadowless illumination obtained. The window space used for showing goods is divided from that portion of the window which gives daylight to the interior shop by a dust-proof space,

the bottom of which is formed of a framing which is glazed with prismatic reflecting glass. On the roof of this space, which is 15 in. deep, are placed two 17-watt lamps over each piece of glass. In the window shown in Fig. 4 there are twelve lamps, making a total of 300 watts. The cubic capacity of the window space is 525 cubic feet, or 0·57 watts per cubic foot. To my mind, this system is an ideal one, and one which could be adopted with advantage and small expense by a large number of existing premises. The interior of the shop, as you will see from Fig. 3, is illuminated by four electroliers, each containing seven 25-watt tungsten lamps in opaque globes. The picture also gives a very good view of the general arrangement of the window space.

This installation, I think, is as fine a one as could be devised. The diffusion of light is so even that, when looking directly at the window from a distance of 10 ft. to 20 ft., it is impossible to see how the illumination is obtained.

A further scheme for window lighting—which, I think, a member of our Society, Mr. Wallis-Jones, must have the credit for introducing on a large scale at Messrs. Selfridge's, and which has been taken up by several of the large West End shops—is that of placing a trough reflector containing either vertically or horizontally placed tungsten lamps across the front of the window just inside the glass, and so arranged that the whole of the light is concentrated on to the goods exhibited. This scheme, which is shown on the sketch (Fig. 6), has its advantages, but, of course, it is not so shadowless as the one I have just described, and there are several very important points necessary to its adoption, the most important being that in cases where the window space is backed by a glazed partition it is necessary to provide blinds that may be drawn when the lighting is in use, for the purpose of stopping the reflection of the lamps and reflectors in the glass.

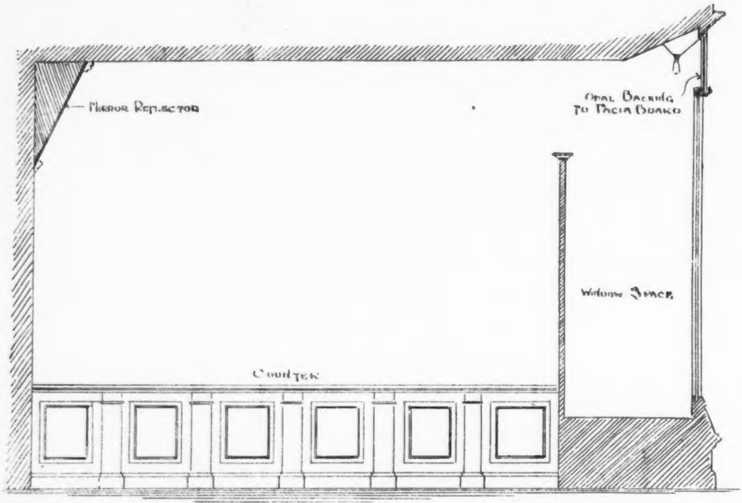


Fig. 9.—Showing illumination of shop, window, and facia board by a single row of tungsten lamps.

In carrying out some tests of an installation of this type recently, some very interesting data were obtained as to the amount of light required for a given window if the articles displayed were of a dark or light nature.

Fig. 7 shows the window dressed with dark goods, viz., carpets, and the total wattage in use at the time the photo was taken amounted to 1,000

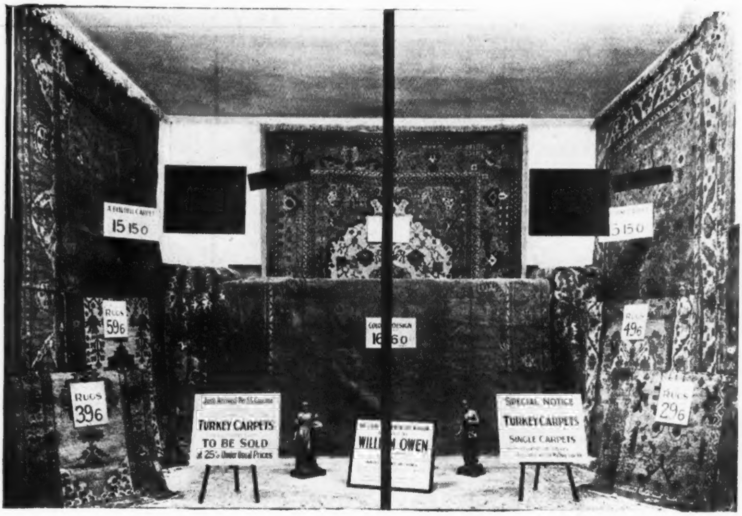


FIG. 7.—Showing window dressed with dark goods.

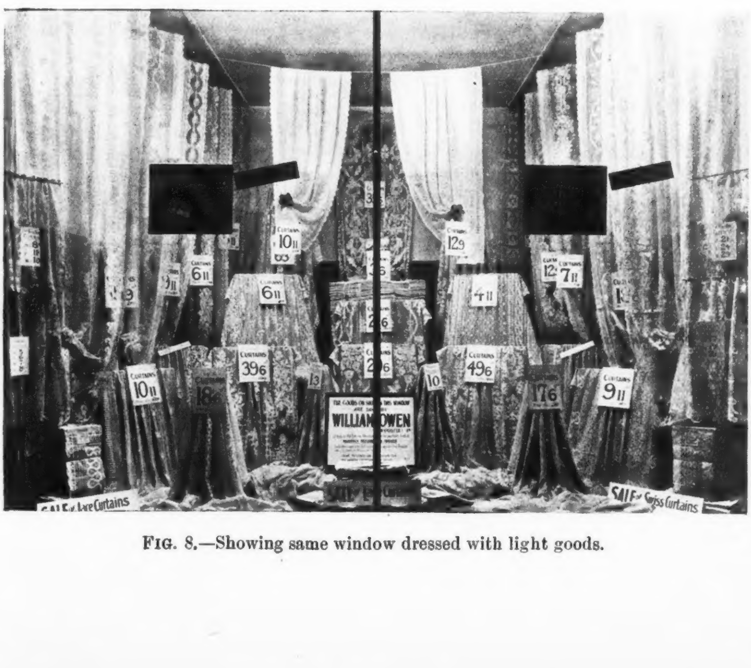


FIG. 8.—Showing same window dressed with light goods.

watts; the window space being 20 ft. by 12 ft. by 12 ft. deep, giving a wattage of ·35 per cub. ft.

and shape, but dressed with light goods. In this case the watts amounted to 700 only, *i.e.*, ·24 watts per cub. ft.

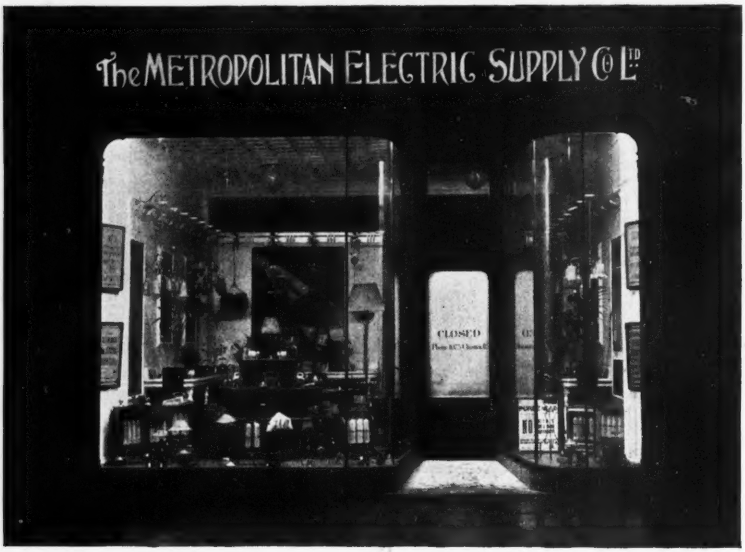


Fig. 10.—View of shop in which the window and the facia board are illuminated by the same lamps.

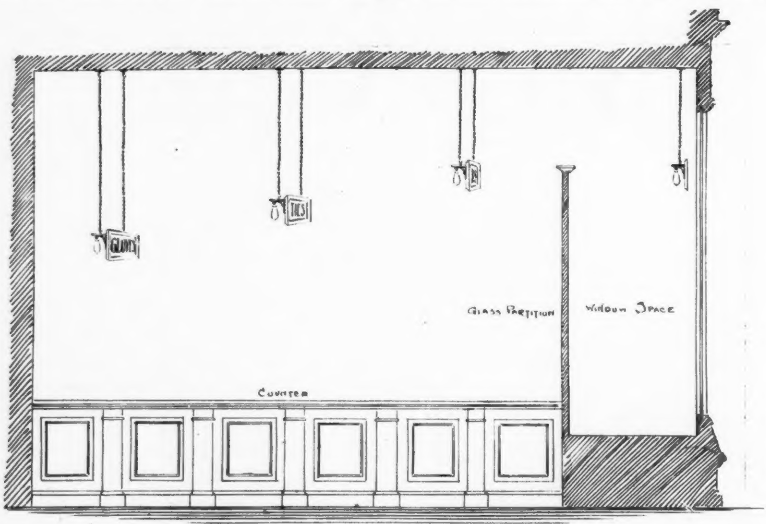


Fig. 11.—**Showing the use of Reflector signs in shop lighting.**

The next photo, Fig. 8, shows another window of exactly the same size

Great care was taken in obtaining these photos to see that the conditions

were in every way similar and exactly the same exposure was give to each plate, with a view to showing that, to the eye, the amount of illumination was practically the same in each case, although in the latter instance 30 per cent less energy was being consumed.

Another scheme of illumination, very much on the lines of the one just mentioned, but where further good use is made of the light source, is shown in the sketch Fig. 9. In the shop in question the top facia board is so lowered and constructed that by placing a single row of sixteen 30 watt tungsten lamps behind it the shop, which is 20 ft. deep, obtains the whole of its artificial illumination from this one source alone, while at the same time the name on the facia board is illuminated. The facia board is constructed of a stout framing, in which are placed sheets of plate glass, on the inside of which is painted the firm's name. These name-plates are backed with stout opal glass, and the row of lamps is suspended about 8 in. away from it. In the picture it will be noticed that a large reflector is shown at the back of the shop; this was fixed with the idea of reflecting some of the light down to the counter and to the forward part of the shop, where shadows from the goods in the window might be cast. The results of the installation were extremely satisfactory. I am sorry I cannot show a photo of this particular shop, but Fig. 10 is of an installation somewhat on similar lines, and shows what result can be obtained.

In a somewhat similar installation to this, recently carried out, there was provided a second name-plate along the bottom of the window, constructed in the same way as the above-mentioned facia, but with only eight 30 watt lamps spaced along the back, and much nearer to the glass than the upper facia, so that they could not be seen from the outside of the window.

The advantages of having a facia board the name on which can be easily read by night as by day must be obvious to all.

Another method which has been adopted with advantage, and which is more applicable to premises where a series of articles are suspended from the ceilings throughout the shop, is the employment of what are known as reflector signs, and it is surprising the satisfactory results that can be obtained by the use of these, and also the very economical way in which it can be done. The sketch, Fig. 11, is of a shop lighted on these lines. This is an identical case, and the whole wattage required for the shop in question, apart from two arc lamps outside for the purpose of advertising, and which have been placed well above the shop window, amounts to only 540 watts. The reflector signs that have been used

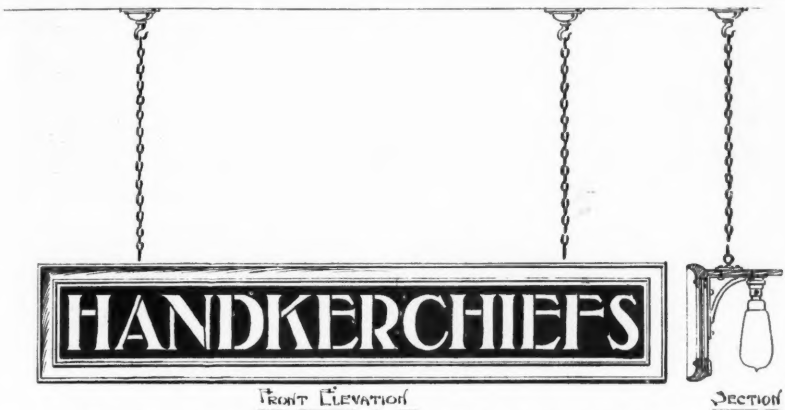


FIG. 12.—Arrangement of sign r eflector to denote a particular department.

are made up as shown in Fig. 12. The signs are constructed of a framing, usually of picture moulding, with a carrier board arranged at right angles at the top of the back, and on this board are fixed the lamp-holders—preferably of a spring type. In the frame is first placed a thin metal stencilled plate and behind this a sheet of opal glass, the glass and stencils being held in position by buttons at the back. In the installation just described the

FIG. 13.—Showing a type of lamp specially designed for illuminating from the outside a closely dressed window.

wording of the stencils is such as to denote that the portion of the counter immediately under is the one for dealing with the goods mentioned. The stencil plates being removable, a few spare stencils will allow of the wording being changed as often as required. In placing the signs down the centre of the shop, care was taken to so arrange their height that none obscured the next behind from the sight to a customer when entering the premises. In this particular case the window is what is known as "back-dressed"—that is to say, the goods shown are not set to the front of the window. If the window should be dressed to the front, the only alteration required would be to remove the window signs and to fix outside one on somewhat similar lines, but of stouter construction. Fig. 13 shows a window illuminated by a form of fitting especially designed by the County of London Electric Supply Co. for illuminating from the outside a closely dressed window. Inside the reflector are placed a number of tungsten lamps, according to the size of the window. The distance at which the fitting is fixed from the window is so adjusted that the whole window gets its fair share of the available illumination. In these cases the outside fittings should be detachable, so that during the several months of the year when outside lighting may not be required they can be moved and stored away. If I may be allowed to depart from the subject of illumination for one moment, I should like very much to emphasize this removal of outside fittings, which, I think, should be made detachable; this should not only apply to the actual fittings, but also to brackets and their supports. Nothing to my mind is so unsightly as to see a lot of more often than not rusty brackets and ironwork on the front of any premises during hours of daylight.

It has been pleasing to see how the use of reflector signs for window lighting has increased during the past year. One of the most recent firms to adopt this method in the West End of London is Messrs. Henry Heath. I have been able to obtain a photo (Fig. 14) which gives a very good idea of the advantages of these reflectors, while at the same time showing how very ornamental they can be made.

A further illustration of screened lighting, more especially for internal window illumination, is the use of "Tubolite," which, owing to its narrow construction, enables it to be placed round the corners of the windows, practically out of sight, and its use also allows of a much closer-to-the-window dressing of the goods dis-

played, without the necessity of providing outside fittings. The objection to the use of "Tubolite" has, up till recently, been the current required, owing to it having been necessary to make the lamps with carbon filaments. This trouble has now been surmounted, and metal filament lamps are available consuming only 1·5 watts per candle-power. I am able to show you two photos of windows illuminated with "Tubolite," one being a furniture shop (Fig. 15) and the second (Fig. 16) a window display of prints in a picture shop. This latter type of display calls for very special care, and I doubt whether any other method could be applied with better results, both from the points of view of illumination and cost.

Coming to type 2, namely, "unscreened" lighting, there are many shop proprietors who prefer this method, and there is no question that for some classes of business, if well carried out, it has its advantages, though only so far as internal illumination is concerned, and not for window lighting. When it has been decided that lighting shall be carried out on these lines, it is advisable, in my opinion, as in the case of indirect arc lighting, to introduce as large a number of small illuminating points as possible in preference to a few powerful ones, so as to subdue as much as possible our great enemy—glare. In many cases it is possible to introduce some types of shades with the object of either subduing glare or concentrating the light in some particular direction. Great attention has recently been given to the scientific development of several types of reflecting shades, and some of the results have been extremely satisfactory. The design of such shades is very important, and, of course, must vary according to the results required. If shades are used, as I have before mentioned, care should be taken to make them easily detachable for cleaning purposes. This especially applies to prismatic glassware, where the results required may be impaired by an accumulation of dust.

Some very effective examples of lighting with a large number of small candle-power lamps have recently been carried out, and one especially attracted me in a boot store. In this case there are fifty tungsten lamps, without shades or reflectors, spaced over the white ceiling; each lamp is of 30 watts, making a total, when the lamps which are used for the illuminated facia are added, of 2,000 watts (or a consumption of two units per hour when the whole of the lighting is going). The illumination in this case is practically even throughout the premises, and owing to the lamps being placed so near the ceiling the effect is pleasant and the glare not in the least excessive.

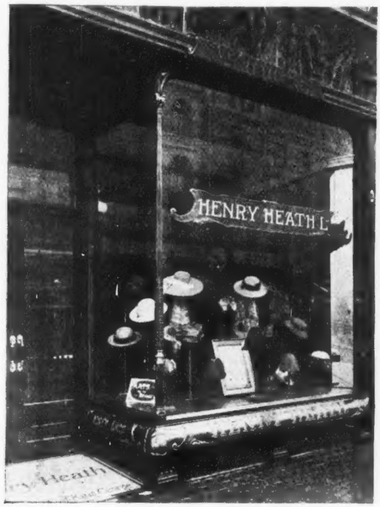


Fig. 14.—Showing ornamental reflector sign in front of shop window.

This one illustration, I think, will suffice for reference to the unscreened method, as although I say the results may be good, they still will not compare with any method where the illuminants are out of sight.

Personally, I am not a great believer in photography for showing the results of lighting, but special care has been taken with the photos I have obtained to see that the conditions are as accurate as it is possible to obtain them.

In conclusion, I should like to again say that I hope these few all too brief

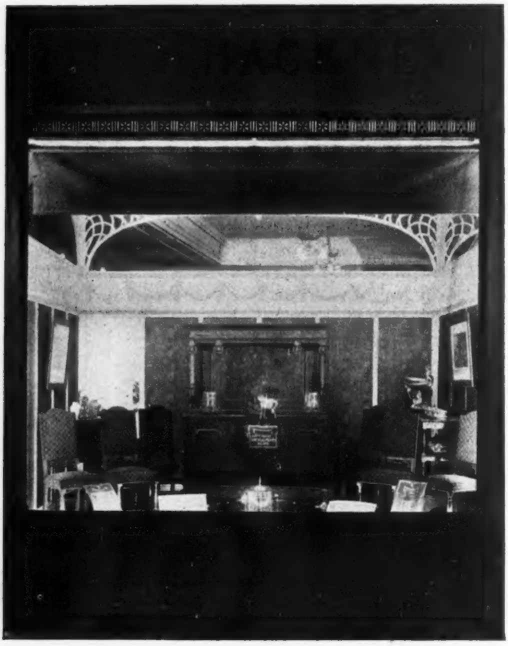


Fig. 15.—Showing the illumination of a furniture shop by "Tubolite."

Fig. 16.—Showing the illumination of a picture shop by "Tubolite."

remarks of mine on the electrical side of the shop lighting question will help to open up a useful discussion on a subject which, in my opinion, has a very large field for useful work for this Society; and I should like also to thank Messrs. Kodaks, Duncan Watson, Adnil Electrical Co., Linolite, and several of the London electric supply undertakings who have kindly helped me to obtain photos and supplied general and useful information.

[Owing to the demands on our space we propose to leave over the account of the discussion of these papers, together with the authors' replies, until the next number.—Ed.]

NEW MEMBERS OF THE SOCIETY.

The names of the applicants for membership, read out at the previous meeting on January 16th, were formally announced for the second time, and these gentlemen were declared Members of the Illuminating Engineering Society.*

In addition the names of the following gentlemen have been duly submitted and approved by the Council, and were read out by the Hon. Secretary at the meeting of the Society on February 20th :—

Members :—

Broadberry, A. E.,	Chief Engineer, Tottenham and Edmonton Gas Co., 639, High Road, Tottenham, London, N.
Butts, E. W.	Engineer to Holophane, Ltd., 26, Palewell Park, East Sheen, S.W.
Carlisle, T. H.	Engineer to Holophane, Ltd., 3, Orchard Studios, Brook Green, London, W.
Lovinson, E.	Assistant Managing Director of the Welsbach Light Co., Ltd., 24A, Sussex Square, Hyde Park, London, W.
Manners-Smith, J. A.	Electrical Engineer, Coniston, Haslemere, Surrey.
Redgment, G.	Electrical Engineer, 5, Bank Plain, Norwich.
Richardson, A. H.	Engineer, Tottenham, and Edmonton Gas Co., 51, Queen's Avenue, Winchmore Hill, London, N.
Sunderland, L.	Electrical Contracting Engineer, 47, Victoria Street, London, S.W.
Tomlinson, J. H.	Ophthalmic Surgeon, Tudor Lodge, Egham.

* *Illum. Eng.*, Lond., Feb., 1912, p. 63.

The International Petroleum Commission.

We have received from Dr. Ubbelohde, the General Secretary of the International Petroleum Commission, a succinct account of the Proceedings at the last Annual Meeting, in Vienna, in January of this year.

At this meeting about 120 delegates from the Chief European States, and also from the United States of America and Canada, were present, and many interesting communications were presented, including a paper summarizing the aims and objects of the Commission, by Prof. Ubbelohde himself. An effort is now being made to standardize the conditions of testing for petroleum, paraffin, benzine, asphalts, &c., in various countries, and the questions of international nomenclature, methods of testing, and conditions of storage and transport are undergoing careful consideration.

With the object of dealing with these matters more fully, national sub-committees, in communication with the chief International Commission, have been established in all the most important countries concerned.

Shop Lighting by Gas.

By A. E. Broadberry

(Mem. Inst. Gas Engineers). (*Tottenham and Edmonton Gas Co.*)

(Paper presented at a meeting of the Illuminating Engineering Society, held at the House of the Royal Society of Arts, John St., Adelphi, London, on Tuesday, Feb. 20th, at 8 P.M.)

As I have been asked to contribute a paper on the above subject, the only excuse I have to make in connection with it is that I fear, owing to the very short notice I had, and coming as it does at a time when I have much other work in hand, it must necessarily be rather inadequate, and fail to do justice to the theme.

In this illustrious Illuminating Engineering Society I cannot hope, on the spur of the moment, to do much in the way of instruction to your members: all I can venture to attempt is to make a few general observations, outline some careful researches which should be made for guidance in arranging the lighting of shops, and to place before you on the screen a few illustrations of well-lighted places of business which owe their brilliance to gas lighting.

Your members are all interested in the business of artificial lighting, on the proper attention to which depends the extent of success of any business, perhaps more than on any other factor or influence—indeed, the lighting company with which I have the honour to be connected has adopted as its motto "Trade follows good lighting"; and in proof of this claim I could instance a case in our area where quite a nice little community lived in almost rural comfort in a sequestered spot just clear of the traffic of a main road for many years, and the tradesmen on "The Green" made comfortable incomes until the advent of tramways along the main road. The development thus caused produced some rows of fine new shops, which were well lighted, and it was soon found that even the good, quiet folk, who for ages had been quite satisfied with the old-fashioned, dismally lighted shops could not resist the attraction of the brilliant illumination, and forsook their old methods and customs to such an extent that the well-to-do shopkeepers on "The Green" were aghast at the fall in their takings. This points to a fact that all illuminating engineers must recognize, namely, that in all towns and cities the standard of illumination is always on the up-grade. In shop lighting the case I have mentioned illustrates it, and shows that the customer appreciates the raised standard, and tradesmen of all kinds must vie with each other, not only to satisfy their customers, but to make the lighting of their shops an advertisement for their wares.

In small country villages one sees sometimes even now a small shop lighted by only one candle, but inside modern town shops the minimum candle-power required for giving a good appearance is three to four candles for every foot of floor area.

Necessarily the light must be greater in some parts than in others, but general evenness is to be aimed at and glare avoided.

Window lighting and outside lighting naturally partake more of the advertising or tradesman's interest; while the inside lighting, in which the customer is more interested, should be of a more useful kind, and both should be carefully studied.

Although your members are all brothers in so far as the promotion of effective lighting is concerned, there are, I know, several rival interests, and I have therefore been laid under instructions to avoid controversial statistics. This I will endeavour to do, and confine myself to matters where interests are blended in one common regard. Rivalry must continue between the various

FIG. 1.—The Lighting of Lewisham High Street.

FIG. 2.—Exterior Shop Lighting at Wood Green.

factions, but I would like to pay my tribute to the good work which is being done by this Society, and by its harmonious meetings, in lessening the misunderstandings and increasing the esteem of all for each other. I will try to avoid any jarring or discordant note.

Gas is to be my theme, but not gas as it used to be understood—a substance which was consumed direct, and obtained a comparatively poor result from the heating to incandescence of carbon particles dissociated in the flame. It takes a long time in many cases to destroy entirely long-established impressions, and unfortunately there are still some, even amongst illuminating engineers who are not actively engaged in the gas industry, and who do not therefore know its great strides, who still picture in their minds—when gas is spoken of—old flat-flame, smoky burners, attached to ugly fittings, and contained in dirty globes or perhaps wire cages. This style of gas lighting is a thing of the past, and the gas lighting with which any scientific society such as this has to deal is the incandescent gas light invented in 1887 by Dr. Auer von Welsbach, and since vastly improved by many other inventors. The gas itself, as sent out from the gas works, is much the same as it used to be; but instead of being so burnt as to heat just as much of the inherent carbon as possible to a poor incandescence, it is all completely oxidized (smoky carbon included) by means of a Bunsen burner, to form a concentrated hot flame about the filaments of a mantle made of highly incandescible materials—a very different problem. So that gas is not now simply burnt to produce light of itself directly, but through another medium; and I am almost tempted to go a step further and claim a very fine block of shops on our area as an example of "Shop Lighting by Gas," as in that case the medium used to transfer the heat energy of the gas into light is merely a gas engine, a dynamo, and a set of best electric lamps. After all, what does it matter whether the medium be one substance or another, so long as the primary agent is the same? Perhaps it would be out of place to go into the candle efficiency per gas consumed as against similar efficiency in incandescent gas lighting, so I will just leave it there, and merely say the block referred to is a good example of a cheap way to produce light from gas by the medium of electric "juice" heating filaments and carbons to incandescence. It shows once more how intermingled our interests become, and points out that soon we shall, as lighting engineers, be able to meet and discuss these points on a general ground without any uncharitableness.

As, later, I shall frequently mention high-pressure lighting, I will here say its object is to obtain a better admixture of air, and so obtain higher flame temperatures. The effect of the higher temperatures is undoubtedly to produce rays of a superior quality from the incandescent media than can be obtained at lower pressures; but, for shop lighting, high pressure is mostly confined to outside lighting for obvious reasons; but the same object of more rapid oxidation of the gas and more intense flames can as easily be attained with high-pressure air and low-pressure gas; and as leakages of the former are of little importance, and would not matter indoors, lighting engineers must give this subject more attention. Both substances being under pressure, adjustments would be easier, and the only drawback would be that six to seven times the bulk of heavier material would have to be handled, and consequently larger mains or much higher pressures used for compressed air.

For crowded communities perhaps the most effective form for general advertisement of localities is uniform rows of outside lighting, all lamps being arranged in regular and corresponding positions throughout a long line, as is done in Lewisham High Street (Fig. 1). Unfortunately, however, as a general rule individual tradesmen require not only varying heights, but also varying units of light, as in Wood Green (Fig. 2). This, unfortunately, is an old illustration: the lights are now much more numerous and varied.

Generally, the lights are well up from the line of vision, and objectionable glare is avoided. The great object of the illuminating engineer ought to be to influence and educate the consumer to adopt a regular and diffused light, and to avoid as much as possible garish glares, which not only hurt the eyes at the time and tend to permanently damage them, but also to create the inward desire to be clear of their influence, instead of stopping to examine the goods displayed in the window. On the other hand, it is a great pleasure to any one to be in a comfortable, genial, and diffused light, the brighter the better, because colours and materials can be better seen and judged the brighter and better the light, so long as it is well diffused.

There is said to be something more—and I believe there is—in the quality of the rays given out by various modes of lighting which it behoves illuminating engineers to study; but I do not claim without further investigation to be qualified to do more than assert that the nearer we get to the solar spectrum the more valuable the effect of the lighting. That there are differences in the requirements of various trades I think nobody will deny, and that all can be met by incandescent gas I believe I could demonstrate individually in all trades by photographs if I had had more time at my disposal; but, short as it has been, I hope that what I now propose to put on the screen will show that gas can satisfy practically all of the varying present-day demands. Incandescent gas enables tradesmen of all descriptions to light their premises most excellently and safely, and, if, as already suggested, trade follows good lighting, it may be used not only as an illuminant, but also as a form of advertisement, and the enterprising tradesman can well and wisely say, "Hang the expense if I double my takings: a few pounds spent

FIG. 3.—Maynard's Confectionery Stores, Harringay.

over good lighting is good business." This, I think, all sides of the lighting industry will uphold.

Fig. 3 gives my first illustration of shop lighting, namely, the exterior of Maynard's Confectionery Stores at Harringay. This style of lighting may be said to be typical of many shops well lighted by gas. The six upright "C" burners are concealed behind the obscured upper portion of the window, and are fitted with mirror reflectors, which direct the whole of the lighting $1\frac{1}{2}$ foot-candles. The visual effect of this form of lighting is very good and satisfactory, and although the illumination in the shadows does fall in places to 1 foot-candle, the objects even there are easily visible. This style of window lighting lends itself admirably to confectioners' and jewellers' shops, where it is desirable to completely enclose the window against dust, which is very prevalent in many main roads, and particularly in the one in which this shop is situated.

FIG. 6.—Exterior of Fruiterer's Shop (Messrs. Lees), Harringay.

downwards upon the wares displayed. This is a very effective form of lighting for any window where the goods are dressed in tiers. Observations were taken by means of the Holophane lumeter of the surface brightness of the white surfaces of the goods in the window as follows: Horizontal white surfaces of the bottom of the window showed 5·6 to 6·9 foot-candles. The vertical white surfaces at various heights showed from 4·2 to 12·5 foot-candles, while the vertical surfaces under the shelves showed only 1 to

Fig. 4 shows the interior of Messrs. Deacock's provision stores at Harringay, which is typical of many others in the same business. It often happens that this class of shop is fitted with light-coloured decorations — either white paint, white tiles or marble—the chief object, of course, being to secure more hygienic conditions. Incidentally, however, the superior reflectiveness considerably helps the general illumination of the shop. This is further assisted in this case by a large mirror at the end of the shop.

FIG. 4.—Interior of Deacock's Provision Stores, Harringay.

FIG. 5.—Exterior of Deacock's Provision Stores, Harringay.

This and the nature of the business is well shown in the photograph. The shop is lighted by sixteen inverted low-pressure burners, arranged on two-light pendants, the burners being 7 ft. from the floor. The shop is $29\frac{1}{2}$ ft. long by $14\frac{3}{4}$ ft. in width, giving a total area of 435 superficial feet. The white marble counters, it will be observed, are arranged on each side of the shop. Photometric observations were made with the following results: On the counters the illumination varied from 10·2 to 12·8 foot-candles; on the Parade as well as lighting the outside counters of the shop. It will be noticed that there are also two low-pressure inverted lamps over the outside counter, to the left of the picture. Observations of the illumination showed on the horizontal surfaces of the counter on this side 24 foot-candles; while that on the other side, having no assistance from the low-pressure lights, showed 19·2 foot-candles. The vertical surfaces of the shelves on the left-hand side showed 9·6 foot-candles. The eggs displayed in the fore part of the

FIG. 9.—Boot Store of Messrs. Freeman, Hardy, and Willis, Harringay.

vertical surface of the shelves on the walls 8 to 12 foot-candles were found; whilst on the floor the observations showed 9·3 to 10 foot-candles. The marble walls on the left side of the picture showed a surface brightness of 9·3 to 10 foot-candles. The illumination is very uniform, and the shop has a pleasant appearance of being very well lighted.

Fig. 5 shows the illumination of the exterior of the same shop, which, as will be seen, is effected by three 600 candle-power high-pressure lamps. These, of course, serve to light the window on the right-hand side were found to have a surface brightness of from 16 to 25 foot-candles. The horizontal illumination of the footway was found to be 5·4 to 4·7 foot-candles on the ground level, while at a height of 3 ft. 3 in. (this height, of course, being chosen as a fair average at which any article would be held in one's hand) above ground level the horizontal illumination was 10·4 to 16 foot-candles.

Fig. 6 shows the exterior of the fruiterer's shop (Lees), also in the Grand Parade, Harringay, which adjoins the provision dealer's last de-

FIG. 7.—Messrs. Lilley & Skinner's Boot Stores, Harringay.

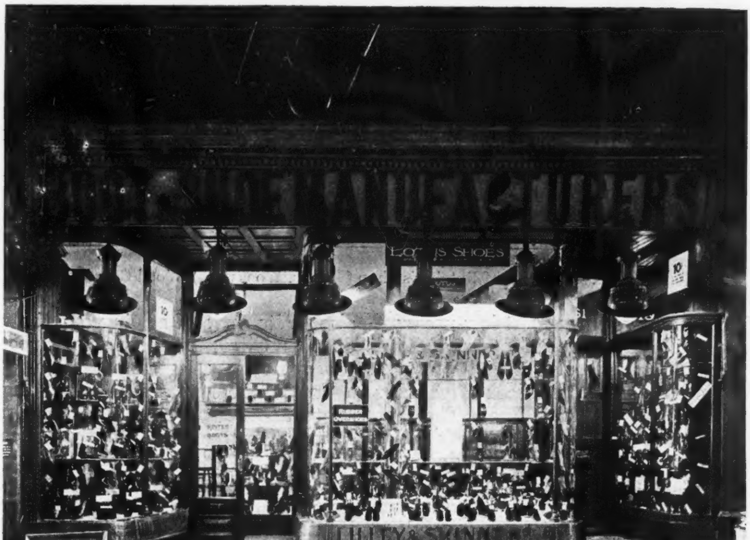


FIG. 8.—Another example of Messrs. Lilley & Skinner's Boot Stores, in the district of the Gas Light & Coke Company.

scribed. In this case the illumination, as shown in the picture, is due to three 600 candle-power high-pressure and two 300 candle-power inverted low-pressure lamps. The latter, however, were turned out before the photometric observations were taken, and the illumination was then found to be from 8·6 to 10 foot-candles over the various surfaces of the wares displayed.

Fig. 7 shows the exterior of the boot shop of Messrs. Lilley & Skinner, this shop also being in the Grand Parade, Harringay. The lighting is chiefly effected by five three-light low-pressure lamps with parabolic reflectors, assisted by one 600 candle-power high-pressure lamp on a long-armed bracket reaching out to nearly the kerb line. The illumination on the surface of the window varied from 31 foot-candles down to 5 foot-candles on the bottom. It will be noticed that the window is rather heavily and thickly dressed, and is only brightened by some decorative curtains at the top of the window above the level of the lamps, which are placed rather low. The lighting appearance of a shop, of course, greatly depends, not only on the goods themselves having light and reflective or dark and dull surfaces, but on the manner in which the window is dressed with the goods and the colour and reflectiveness of the background. To illustrate better what I mean, Fig. 8 shows another shop of the same firm in the district of the Gas Light and Coke Company. Here it will be seen that the dressing of the window is entirely different, showing that even the same firm has considerable variety, not only in its method of lighting, but also in its style of setting out the window, and it is impossible to expect to get uniformity in shop lighting. As a further illustration of this, Fig. 9 shows another boot shop in the Grand Parade, Harringay—that of Messrs. Freeman, Hardy & Willis—where the window lighting is entirely done by four 600 candle-power high-pressure lamps. The illumination on the surface of the window varied from 100 foot-candles at the top to 4·5 at the bottom.

Fig. 10 shows quite another class of trade, namely, a butcher's shop, Messrs.

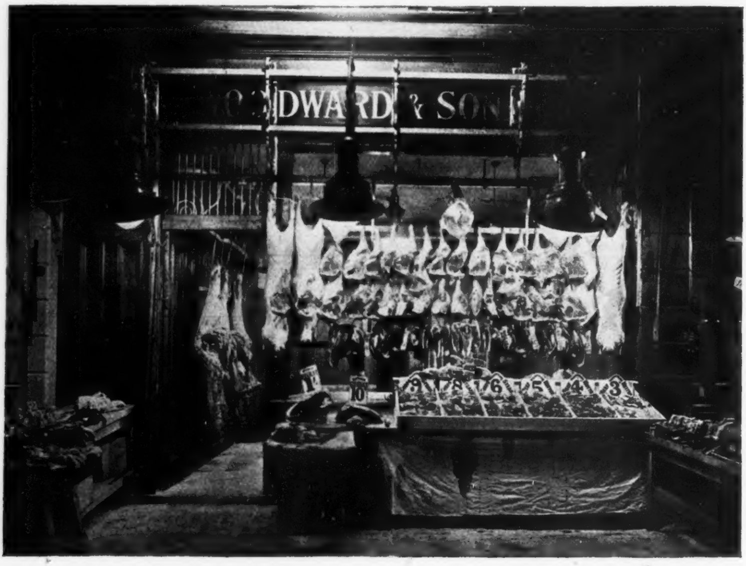


FIG. 10.—Exterior of Butcher's Shop (Messrs. Woodward), Wood Green.

Woodward, at High Road, Wood Green. This is an open-fronted shop, as is usual with butchers, and the lighting is done by three 600 candle-power high-pressure lamps, with parabolic shades on the outside, and with one 600 candle-power high-pressure inverted lamp with concave shade, and two inverted low-pressure burners with opal shades on the inside. The lighting here again is good. The illumination over the horizontal surfaces outside the shop at the counter level varied from 11·2 to 13·8 foot-candles; while the illumination on the joints of meat hanging on the top rails outside the shop was 76 to 80 foot-candles; and that on the counter inside the shop was 10·6 to 10·9 foot-candles. Observations on the vertical surface of the cash register showed 3·5, and on the inside walls 4·8 to 5·8 foot-candles. The illumination on the floor of the shop varied from 5·8 to 6·1.

Fig. 11 shows the interior of a druggist's store — Heppell's, in the Strand. This interior is entirely lighted by inverted low-pressure burners, which are fitted with a system of electric ignition, and can be controlled from distant points, and from more than one if required. The small electric current necessary for the purpose is supplied by a 6-volt dry cell battery, and the mere pressing of an ordinary bell-push simultaneously operates the valve and lights the gas by means of a platinum igniter, which glows during the time that the button is being pressed and the current passes. This is typical of several other systems of distant control for gas lighting; but other systems require a by-pass, whereas the system in use here, having electrical ignition, saves the trouble and waste of the by-passes and the nuisance of matches. The apparatus itself can be seen in the photograph just above the burner. The extinguishing is effected by again pressing the push, thus again operating the valve. The advantages of the various systems of distance control are, of course, not only the convenience, but the very

Fig. 11.—Interior of Druggist's Store (Messrs. Heppell's), Strand.

considerable economies that can be effected by switching off any lights not required at the moment, or which are required intermittently. Observations of the illumination effects in this interesting installation will be taken in time for the meeting, but cannot be included in the paper.

I next propose to put upon the screen Figs. 12 and 13, showing another shop—a confectioner's, in the district of the Gas Light and Coke Company—taken from the same position, in one case with the inside lights of the shop window only in operation. Here it will be seen that without any other lighting the appearance is very good, but the name on the facia is unreadable. In the second case the inside lights are extinguished, and the outside lights only in operation. Again, the general effect of the lighting in the window is good, and notwithstanding the reflectors to the high-pressure lamps the name on the facia is readable. I call attention to this point in view of the experiments which have been made in regard to this subject, and will be alluded to next.

In the foregoing illustrations of outside lighting it will have been noticed that there was a great variation in the appearance and effect due to the different heights and positions of the lamps, and also due to the variety of the lamps themselves and the shades with which they were fitted. This suggested the desirability of experimenting and investigating as to the correct height and position of outside lamps, which is undoubtedly a matter worth very careful consideration. In many cases, even in the illustrations I have given, the lamps seem to be unsuitably placed, generally in the direction of being too low, this being often due to the interference of shop blinds. The effect generally is to dwarf the appearance of the premises, and to render the upper portion of the window more or less invisible. Two types of lamps were used in the experiment, namely, high-pressure inverted, fitted with parabolic reflectors—spaced in one experiment 6 ft. apart, and in another experiment 5 ft. apart, and in another 4 ft. apart—and low-pressure inverted lamps, also fitted with para-

1000 C.P. H.P. INVERTED LAMP WITH "PARABOLIC" REFLECTOR

VERTICAL DISTANCE FROM CENTRE OF MANTLE	LAMPS SPACED 6 FEET APART				5 FEET APART			4 FEET APART		
	OPPOSITE CENTRE LINE OF LAMP	1 FOOT SIDEWAYS	2 FT SIDEWAYS	3 FT SIDEWAYS	OPPOSITE CENTRE LINE OF LAMP	1 FT SIDEWAYS	2 FT SIDEWAYS	OPPOSITE CENTRE LINE OF LAMP	1 FT SIDEWAYS	2 FT SIDEWAYS
0: FEET	66	47	23	28·8	68	53	46	75	60	65
1.	94	83	62	57	102	92	78	116	111	99
2.	79	66	63	47	87	77	77	103	87	107
3.	70	52	44	43	74	58	59	80	72	70
4.	36	26	30	33	42	30·6	42	44	43	47
5.	21·3	18·2	18·1	18·6	23·4	22·4	22·2	25·4	25·5	26·8
6.	15·5	13·6	12·5	12·2	17·9	15·6	15·3	18	17·6	14
7.	10·3	7·9	7·7	[illegible]	10·5	10·4	9·5	11·7	11·1	11
8.	7·1	6·8	5·8	6·4	8·8	7·5	7·4	8	9	8·6
9.	5·8	5·5	4·4	4·5	6·5	5·6	5·8	6·8	6·8	6

CENTRE OF LAMP 39 INCHES FROM VERTICAL TEST SURFACE

FIG. 14.—Table showing the Variation of Illumination on a Shop Front with Variation of the Spacing of Lamps (High Pressure).

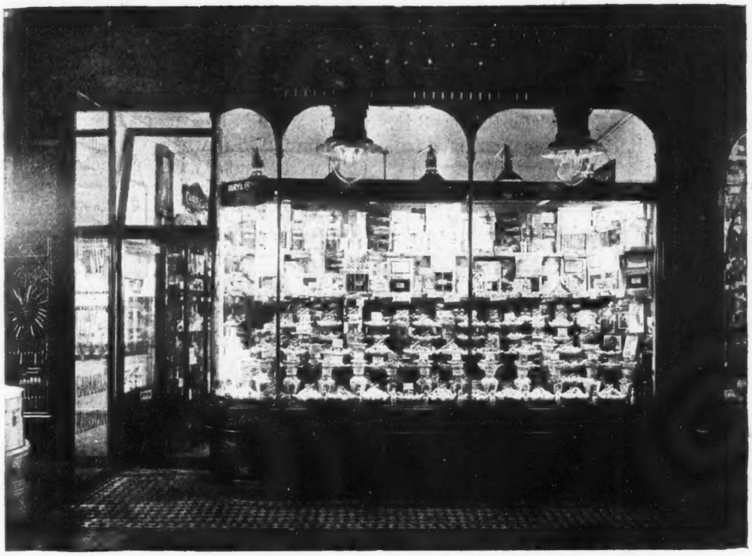


FIG. 12.—Lighting of a Confectioner's Shop with Interior Lights only.

FIG. 13.—Lighting of the above Shop with Exterior Lights only.

bolic reflectors. For the purpose of the experiment the lamps were fixed 39 in. out from the vertical surface intended to represent a shop front, and the lighting effects were taken on a vertical line directly behind each lamp, and on similar lines, 1, 2, or 3 ft. distant from it on the vertical surface, with the results shown by Fig. 14.

The light directly behind the lamp, it will be seen, varied from 66 foot-candles on the level of the mantle, increasing to 94 1 ft. below, down to

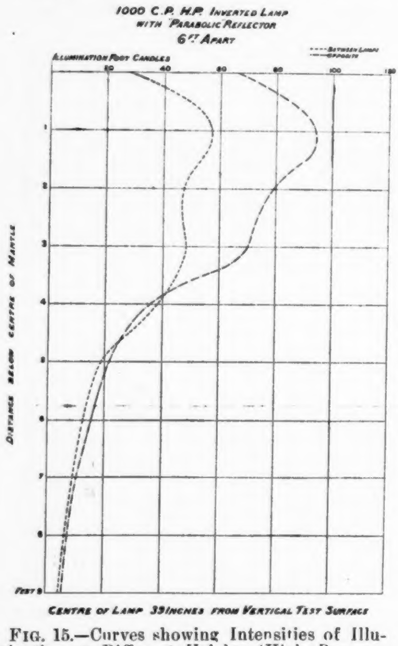


FIG. 15.—Curves showing Intensities of Illumination at Different Heights (High Pressure Lamps 6 ft. apart).

5·5 foot-candles 9 ft below, and 3 ft. sideways (that is to say, midway between the lamps); the illumination varied from 28·8 foot-candles at the mantle level, increasing to 57 1 ft. below, down to 4·5 foot-candles 9 ft. below. This is shown plotted out in a curve in Fig. 15, which shows in an interesting manner the variation of the light given at different heights. Observations were, unfortunately, not taken above the level of the mantle, but there appeared to be almost complete gloom, and the effective lighting was only from the mantle level downward. If any part of the window surface, for example, were more than 1 ft. above the centre of the mantle, the window and its contents would be in complete gloom. In connection with this it may be observed that, with reflector lamps, the apparent darkness even renders the upper space more suitable for luminous signs. The curve for high-pressure lamps (Fig. 16) spaced 4 ft.

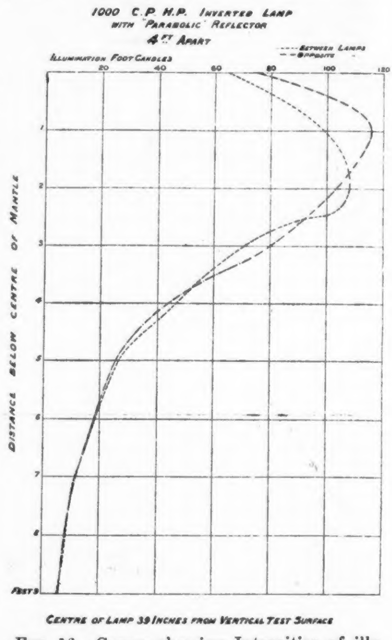


FIG. 16.—Curves showing Intensities of illumination at Different Heights (High Pressure Lamps 4 ft. apart).

apart is very similar; but, naturally being closer together, the variation between the curve taken directly behind the lamp and the one midway between is not so great. The next Table (Fig. 17) shows the observations taken of the low-pressure lamps spaced 4 ft. apart.

The effect in the curve is very similar to the high-pressure lighting, except that the increase in the readings 1 ft. below the centre of the lamp is not found in the low-pressure as with

the high-pressure lamp (Fig. 18). A careful study of these figures brings out many points, such as the effect of spacing. Take, for example, the values found 4 ft. below the centre of the mantle in the lamps spaced 6 ft. apart; the maximum effect was found to be 38, and the minimum 26; while at 5 ft. apart it varied from 42 to 30·6; and at 4 ft. apart from 47 to 43. The light from the various lamps would, of course, overlap, and the readings would be the result of the combined effect. From

300 C.P. LOW PRESSURE INVERTED
3 LIGHT LAMP WITH PARABOLIC SHADE

VERTICAL DISTANCE FROM CENTRE OF MANTLE	LAMPS 4 FT. APART		LAMPS 6 FT. APART	
	OPPOSITE CENTRE LINE OF LAMP	2 FEET SIDEWAYS	OPPOSITE CENTRE LINE OF LINE	2 FEET SIDEWAYS
0	35	22·4	29·6	15·2
1	36	22·4	29·8	16·3
2	30·8	19·2	25·2	14·6
3	19·2	20·8	15·4	14·4
4	15·6	14·8	12·4	10·9
5	·	·	·	·
6	7·1	5·8	5·1	5
7	·	·	·	
8	3·3	2·6	2·6	2·3

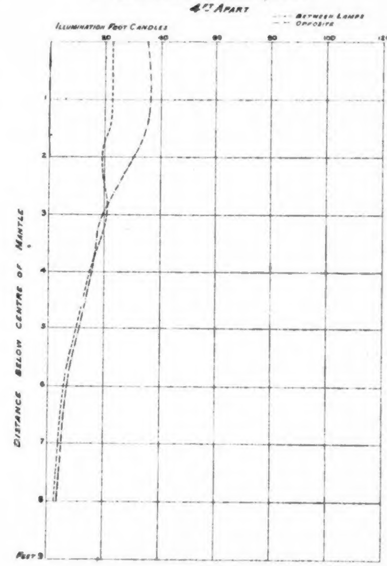
CENTRE OF LAMP 39 INCHES FROM VERTICAL TEST SURFACE

Fig. 17.—Table showing Variation of Illumination on Shop Front with Variation of the Spacing of Lamp (Low Pressure).

the appearance of the curves one would almost expect the bottom of the window to be inadequately lighted; but as generally goods are displayed in the window more or less vertically at the top and inclined at the bottom, the goods at the bottom are in a position to be thoroughly well lighted, and as a matter of fact, owing to the fall being gradual, there is no appearance of gloom at the bottom.

There are many other points besides this question of height and spacing that absolutely call for careful investigation and research; for instance, the various effects of different kinds of reflectors and shades, their shape and angle, and also the varying effects of different kinds of globes—clear, frosted, opal, &c. Also the different effects of bright and reflective and dark and dull ceilings and surroundings, including the goods themselves. The matter of heights and spacing would not be a difficult matter for any one to arrange with the various appliances which are now in existence for raising, lowering, and travelling gas lamps at will. In a short paper such as this there is no

300 C.P. LOW PRESSURE INVERTED
3 LIGHT LAMPS WITH PARABOLIC SHADES
4 FT. APART



CENTRE OF LAMP 39 INCHES FROM VERTICAL TEST SURFACE

Fig. 18.—Curves showing Intensities of Illumination at Different Heights (Low Pressure Lamps 4 ft. apart).

room to deal with these points, but I trust that what has been said and shown may help to add interest to the subject and promote good discussion which will be helpful to us all.

In conclusion, I have to express my indebtedness to one of your members, Mr. J. G. Clark, who has not only supplied me with the tables and diagrams last given and the notes thereon, but also kindly assisted Mr. A. H. Richardson in the preparation of the information and photographs necessary for the illustrations given of 'Shop Lighting by Gas.'

The Illuminating Engineering Society.

(FOUNDED IN LONDON, 1909.)

Annual Dinner.

(Held at the Trocadero Restaurant, London, W., on February 15th, 1912.)

THE second Annual Dinner of the Illuminating Engineering Society was held at the Trocadero Restaurant (Piccadilly, London, W.), on Thursday, February 15th, the President, Prof. S. P. Thompson, D.Sc., F.R.S., being in the chair.

A large gathering of members and their friends were present. The proceedings throughout were most enjoyable, and the speeches and representative nature of the gathering provided an excellent illustration of the objects of the Society.

In the course of the evening the Assistant Secretary, Mr. J. S. Dow, read out a few letters from distinguished guests who had written congratulating the Society on its progress and regretting their unavoidable absence.

The President of the Royal Society had explained that only the fact of his having to hold a reception of the Fellows on that night prevented his attendance. Mr. S. Z. de Ferranti, President of the Institution of Electrical Engineers, had likewise been unavoidably detained at the last minute, and had written: "I am very sorry that I cannot come, as I should much like to have been there to support your esteemed President." Sir Wm. Ramsay had added to his expression of regret the words, "Please convey to the President, my old friend, and to the Council, my thanks for their kind invitation." Sir James Crichton Browne wrote: "I am sorry to lose this opportunity of showing my interest in the work." Dr. Haldane (another of the Society's Vice-Presidents), in replying, had taken the opportunity of offering his congratulations on the growth and prosperity of the Society; and Prof. Vivian Lewes had specially written expressing his good wishes for its welfare.

Special mention should be made of a letter, couched in very kind terms, from Sir Arthur Whitelegge, H.M. Chief Inspector of Factories. Dr. T. M. Legge and other representatives of the Factory Department of the Home Office, had also hoped to be present, but had been detained elsewhere.

Among other letters received, he might mention those of the Presidents of the Royal Institute of British Architects, the Institute of Sanitary Engineers, the Royal Sanitary Institute, the Ophthalmological Society, and the Society of Architects; Prof. Vernon Harcourt, Sir Wm. Abney, Sir Henry Trueman Wood, Prof. Callendar, Dr. R. T. Glazebrook, Dr. Walter, Dr. C. V. Boys, Major G. C. Glyn, &c., all of whom had expressed their deep regret at being unable to be present.

Toast: "The Illuminating Engineering Society."

After the loyal toasts had been duly honoured,

PROF. R. S. CLAY (Principal of the Northern Polytechnic) proposed the toast of "The Illuminating Engineering Society." He said that three years ago, when the Society was first started, illumination generally was very little understood. That the Society had succeeded in its objects was well shown by the fact that the membership was now 330, which included 120 Corresponding Members all over the globe.

The Society had been discussing a large number of subjects of national importance—the lighting of schools, for instance. It was most important to care that if children were going to use their eyesight in reading and writing, they must not be handicapped in having an insufficient supply of light. The papers which had been read on this subject before the Society showed that it was time that a really scientific basis for such illumination should be evolved. The same thing applied to our public buildings and private houses,

although the latter was, perhaps, a much more difficult problem.

Another indication that the Society was doing good work lay in the invitations it was receiving to various international congresses, culminating in the Society being asked, at the Electrical Congress at Turin last year, to form an International Commission with reference to lighting. But behind a Society like theirs must be something more than the mere value of a society. That was the dead thing. They must have the living element. The Society had two living elements in their Hon. Secretary and their President. The former was undoubtedly the right man in the right place, whilst the latter, in addition to being an expert engineer, was one of the foremost exponents and workers in optics, was a good business man, and, lastly, had wonderful tact and courtesy.

Prof. S. P. Thompson, D.Sc., F.R.S., the President, responding to the toast, said it was one of the great advantages of the Society that it possessed, not only a President who only came to the meetings occasionally, but a Chairman upon whom the responsibilities were largely placed, so that the duties of Presidency sat rather lightly. It was a source of great satisfaction that the Society had made its mark from the beginning. There was a real need for it.

Moreover, during the three years of its existence, had there been any conflict between the varied interests represented in the Society? He thought not. It was a case of the lion and the lamb, or the leopard and the kid, lying down together although he was not sure which was either.

Before the Society came into existence, he did not think that, with the exception of one or two extreme specialists, anybody knew that photometry had anything to do except measure the brightness of light. The text-books said nothing about anything else. The Society, however, had been successful in stimulating invention on the part of their younger and more active members, and there was not the slightest excuse for any architect, surveyor, inspector of factories or schools, or in any Government Department not knowing what was the brightness of any surface or the illumination provided. That was a very great step which very few had fully realized the importance of.

There was another important thing which the Society had done, viz., to bring into focus a number of important questions, such as the lighting of schools and shops, libraries, hospitals, picture galleries, &c. But they had only touched the fringe of the subject. There were still an enormous number of questions to be discussed in the light of modern knowledge and apparatus. The lighting of pictures, for instance, was one example. Most members of the Society knew one small piece of advance that had been recently made by their younger members in the invention of a lamp for lighting pictures which would give uniform illumination from top to bottom, no matter from what position the picture was viewed. By its aid there was no light reflected at all in the glass of the picture. This would be a most advantageous thing in our picture galleries.

He regretted that Sir Arthur Whitelegge was not present. He was the Home Office official who could be numbered among the Society's best friends, in being willing to adopt their suggestions or take counsel from them, with the object of bringing these things to the knowledge of proprietors of factories and others. Work people need no longer be allowed to work without sufficient illumination, which was equally essential with proper ventilation, whitewashed walls, and fencing of machinery.

There was one other direction in which something still remained to be done. It was more than thirty years ago that he was consulted by a young and rising artist with a view to the efficient artificial lighting of a new studio which he had just taken in London, his difficulty being that when artificial light was turned on, all the colours seemed wrong. He suggested to the artist that the best thing to do would be to put in a couple of arc lamps which were nearer to daylight than anything else. He also

advised him to have them fitted so that the light from them fell as nearly as possible in the same direction as the daylight. Further, he suggested switching on the lamps about an hour before it was absolutely necessary, so that, as the daylight failed, the difference between the natural and the artificial light would hardly be noticed. The recommendation was very successful, and this artist was now a distinguished member of the Royal Academy. There was much to be done with regard to illumination in this direction even now, especially that the means at our disposal were so much more perfect.

Toast: "Kindred Societies."

MR. F. W. GOODENOUGH (Chairman of Council) proposed the toast of "Kindred Societies." He said that this toast was a proper one to be honoured by the Society, for if it were going to secure the success which they had hoped, it must be very largely by their being able to interest kindred Societies in their work. They must interest, not only electrical and gas engineers, but also the architects, who had so much to do in advising on matters of illumination with regard to public buildings, and so on.

One of the finest results of the formation of the Society had been the establishment of the most friendly relations between members of a number of societies whose interests might at first sight appear divergent. The Illuminating Engineering Society welcomed such other societies as the Optical Society and the Architects' Societies, because it lay with them to such a large extent to advise people, who, he was glad to say in these days, were more and more seeking the advice of the supplier of the particular illuminant they used than was the case formerly. In this connection he expressed the opinion that it was wise on both the part of the gas and electrical engineers to put at the disposal of the public all the skilled advice they possibly could on the subject of illumination, because it was good business both from the point of view of policy as well as national welfare.

MR. R. G. SHADBOLT (President of the Institution of Gas Engineers), replying to the toast, said that next year the Institution of Gas Engineers would celebrate its jubilee as a technical society. Although the progress of that Society might not have been so rapid, and gas engineers might not have moved apparently in the past so rapidly as they were moving to-day, yet it was a valuable sign of the times that both gas and electrical engineers now had a common ground upon which they could not only serve the public interests, but also their own at the same time. He recalled how, thirty years ago, Mr. Newbigging had pointed out the importance of considering illumination, apart from the source of light, and it was most pleasant to see how his ideas were being widely realized to-day. If the Illuminating Engineering Society went forward on the lines indicated, and made as much progress in comparison during the next three years as during the past three years, it would have fully justified its existence.

If this progress continued, gas engineers would be compelled in much larger numbers than at present to join the Society. Its work appeared to be of such a character that they could no longer stand aloof from it in numbers if they were to arm themselves with the necessary knowledge and information requisite to discharge their duties properly. The whole philosophy of business life was how could they best meet public requirements with the least possible outlay to them, and, incidentally, with the greatest amount of profit to themselves. In conclusion, he wished the Society a vigorously successful career, and hoped that on some future occasion he would be permitted to join their ranks as a member.

MR. W. M. MORDEY (Past-President of the Institution of Electrical Engineers) also responded to this toast. It was usually felt, he said, that the formation of subsidiary societies was to be regretted on the ground that there was always a parent society which covered the ground sufficiently.

But, with regard to the Illuminating Engineering Society, no objection of this kind had ever been present in his mind—nor, did he believe, in the mind of any electrical engineer. It covered a ground of its own which to a large extent was outside the field covered by any existing institution. It did useful work that could only be done by a combination of people who belonged to quite different societies having their own distinct objects.

The impossibility of the Institution of Electrical Engineers doing the work of the Society would be clear, because, according to its Articles of Association, it could not possibly accept people as members from other branches of applied science. The same applied to the Institution of Gas Engineers and to other institutions, and on this ground alone, the Illuminating Engineering Society was certain to have a very prosperous future. The rival engineers in its membership were by no means enemies. Gas engineers would agree that their combination with electrical engineers had done a very great deal of good. They had helped one another, if only by raising the standard of illumination.

As an additional instance in which progress was gradually going on around us, Mr. Mordey, after referring to some exceedingly interesting experiments recently made by Dr. Harker at the Royal Institution, in which he demonstrated a method for the production of electric current from heated carbons, mentioned an improvement in arc lamps which he had come across. He had to order some A.C. arc lamps, and in looking through the catalogue of one of the makers, he came across the extraordinary statement—at any rate to him—that, by the use of choking coils in series with the arc, instead of a fixed resistance, there was a gain of 30 per cent in light. The existence of this effect he had demonstrated for himself by the aid of Mr. Dow's lumeter.

This demonstrated how improvements were constantly being made, and to him it was of very great interest. They knew that, however satisfactory an ordinary means of lighting might be, they were still exceedingly inefficient considered as producers of light. He would not say what the efficiency of the lamps was, but he knew it was very low indeed, and there was in this respect an enormous field in front of them. His own belief was that our descendants would not have any means of lighting such as we had at present, but that there would be some improvements in luminous paint methods, and that our houses would be lighted by walls and ceilings treated with luminous paint, which would be energized during the day by lamps, electric or gas, when they would not be a nuisance to anybody, and that at night we should just have a gentle and sufficient light ready whenever required.

Toast: "Our Guests."

Mr. R. J. Wallis-Jones proposed the toast of "Our Guests," with which he coupled the names of Dr. W. Garnett, Educational Advisor to the L.C.C., and Dr. F. G. Kenyon, Chief Librarian of the British Museum. Dr. Garnett, he said, was a man of so many intellectual parts that it was very difficult to know at which end to begin. In his present capacity, however, as Educational Advisor to the L.C.C., he was closely in touch with the question of illumination, and was in full sympathy with the work of the Society, particularly with reference to the lighting of schools as a question of national importance. Dr. Kenyon had also, in his capacity as Chief Librarian at the British Museum, realized the importance of proper illumination; no doubt the committee which was dealing with illumination of libraries, would look forward to having good advice from him.

Dr. W. Garnett, replying, expressed the opinion that it was not so much the need for more lighting physically that existed, as a more scientific distribution of it. Differentiation seemed to be required to secure efficiency, and this could only be brought about by proper co-ordination of the interests involved. In this work the Society was doing a great deal of good, and it

was only by bringing these people together, and by the interchange of ideas, that we could get developments at a greater pace than hitherto. They must bring together the gas engineer and the electrical engineer, the architect and those responsible for the ventilation of our buildings; and, likewise, bring together the physiologist and the medical man who studied the effect of different kinds of light upon the eye, and make them all work together.

In this connexion Dr. Garnett recalled some experiences of his own in connexion with illumination, all of which presented interesting analogies with the work of the Illuminating Engineering Society.

At Cambridge the capabilities of mathematicians had sometimes been frittered away in academic problems because they did not know there what were the problems awaiting solution. Mr. Trotter, however, whose absence he regretted, was the first to apply his Cambridge mathematics to the equal distribution of light from a given source. In the Optical Institute which he hoped to see in existence before long, they wanted to bring the mathematician and the physicist to work side by side with those engaged in the manufacture of optical instruments; and this also would help to further the objects of the illuminating engineers.

Dr. F. G. Kenyon also replied. He said he represented those who were using the light. In that capacity he had very much to learn from the illuminating engineers, and suggested that the Society, in addition to standardization of methods and apparatus, should also standardize opinions. This would be of great assistance to those in his position in aiding them to seek advice.

Toast: "The Chairman."

Mr. L. Gaster (Hon. Secretary) proposed the last toast of "The Chairman," which was received with great enthusiasm and the singing of "For he's a jolly good Fellow." Mr. Gaster laid stress on the enormous advantages which the Society had received from Dr. Thompson's knowledge of languages, his wide sympathies, and his international connection. It had resulted in the Society becoming practically an International Society, and forming a link between American and European Societies. Without in any way wishing to depreciate the value of any one who might hereafter hold the position of President, he said that no one could be looked upon with greater respect than Dr. Thompson. He therefore hoped that, in view of the lightening of the Presidential duties by the services of their admirable Chairman of Council, Prof. Thompson would see his way to continue in office next year. The International Commission on Illumination which the Society had been asked to form furnished a very strong reason for making this request, and he felt sure that it would be difficult to find any one more fitted to preside over such a gathering than Prof. Thompson.

Prof. S. P. Thompson, in reply, briefly thanked those present for the very kind reception which they had given to the toast, but said that the proposal of Mr. Gaster would require very careful consideration; there were limits to human endurance, although the duty had been a pleasant one. He wished the Society a prosperous session, and felt confident that, with Mr. Goodenough as chairman, the Society would continue to be a success.

At the recent meeting (Annual Meeting) of the Elektrotechnischer Verein, of Berlin, Mr. L. Gaster, the Hon. Secretary of the Illuminating Engineering Society was elected a member of the Council for the years 1912, 1913, and 1914.

The Council has made a practice of securing distinguished representatives in the important countries in Europe, and the invitation to Mr. Gaster to fill this position is an interesting illustration of the international recognition the Illuminating Engineering Society now receives.

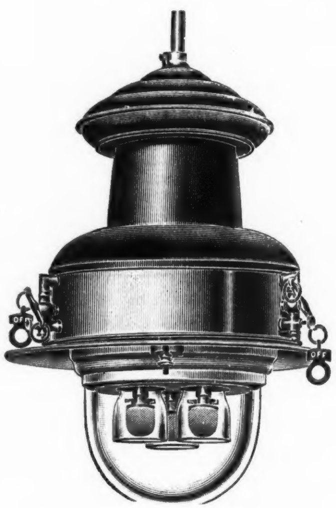
TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

The "Bourne" Lamp for Exterior Lighting.

We have received particulars from **Messrs. A. E. Podmore & Co.** (34, Charles Street, Hatton Garden, London, E.C.) of the "Bourne" Inverted Incandescent Gas Lamp, which embodies several features of special interest, and forms a thoroughly efficient unit for outside lighting. It can be supplied with two, three, or four lights, and each burner



s under separate control, so that the intensity of the lamp as a whole can be varied to suit circumstances. The burners are designed to get the full effect of pre-heating the mixture, and the gas and air regulators are easily accessible. The lamp can be fitted with a parabolic reflecting shade which makes it specially suitable for shop window lighting.

Mazda Traction Lamps.

The strength of the drawn wire lamp has greatly extended the field of use for metal filament lamps. It will be recalled that we recently referred to some very severe tests which had been carried out on Mazda drawn wire lamps on battleships under target fire. We understand that the **British Thomson Houston Company** (Mazda House, 77, Upper Thames Street, London, E.C.), following on some satisfactory tests of these lamps by leading tramway companies in this country, have standardized a line of Traction Lamps, rated at such an efficiency as will give a length of life that is economical for the conditions of tramway power costs. These lamps are supplied for series burning, so as to operate in the standard arrangement of five lamps in series for railway voltage of 500, 550, or 600 volts.

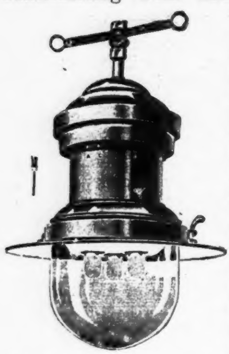
It is estimated that by using these lamps, even with cost of power at the very low rate of ½*d.* a unit, a saving of very nearly 2*s.* per lamp could be effected; and there is the further consideration of the attractiveness and advertising power of improved car lighting which should justify expenditure in somewhat higher first cost.

The accompanying illustration shows a "sticker" which the **British Thomson Houston Company** are now issuing for affixing to correspondence, &c. This

effective reproduction of the "Sun's Only Rival" showcard is printed in colours, and should be found useful by contractors and others.

The "Ukay" Lamp for Shop Lighting.

Messrs. Falk, Stadelmann & Co., Ltd. (83–87, Farringdon Road, London, E.C.), the manufacturers of the above lamp, draw our attention to its extensive use for SHOP LIGHTING purposes. It will be recalled that we reproduced an illustration of this lamp, together with some description in our January issue. Among its chief features may be mentioned its mechanical strength and capacity for withstanding wear and decay due to severe variations of temperature and inclemency of weather. This latter feature has been gained by careful attention to the design of the exterior case, and is particularly important in lamps intended for continuous outside tervice. The consrol of the gas and air regulation by means of a loose key is a speciality of this lamp to which reference has previously been made. This is a valuable addition, which prevents the regulation once determined by the officials of the gas company from being tampered with by the uninitiated.



Contracts for Metal Filament Lamps.

Messrs. Siemens Bros. Dynamo Works, Ltd. (Tyssen Street, Dalston, London, N.E.), inform us that they have obtained contracts for the supply of TANTALUM TRACTION LAMPS to the Great Eastern Railway, the Aberdeen White Star Line, the Allan Line, and the London County Council for their tramway cars. They are also to supply "Wotan" lamps for the complete street lighting scheme of Brighton Corporation.

Messrs. The General Electric Co., Ltd, have again secured the POST OFFICE CONTRACT for metal filament lamps fo the next six months.

A special short course of lectures on 'Gaseous Combustion as Applied to Furnace Heating' is being given on Tuesdays at 7.30 P.M. at Westminster Technical Institute, Vincent Square, S.W., by A. W. Onslow, Esq. The lectures commenced on February 20th.

Catalogues Received.

From **Messrs. Siemens Bros. Dynamo Works, Ltd.,** their latest list of ELECTRIC RADIATORS fitted with luminous lamps, including many ornamental designs of a pleasing character. Also from the same firm, copies of the most recent lists of "Wotan," "Tantalum," and carbon filament lamps.

From **Messrs. The General Electric Co., Ltd.,** a very comprehensive and fully detailed catalogue of OSRAM LAMPS.

From the **Holophane Company** of Newark, U.S.A., a portfolio of ARTISTIC LIGHTING FIXTURE DESIGNS, executed by some of the leading American firms, and incorporating some of the most recent developments in artistic Holophane glassware, and intended to illustrate the harmonious relations of this glassware with decorative fixture design.

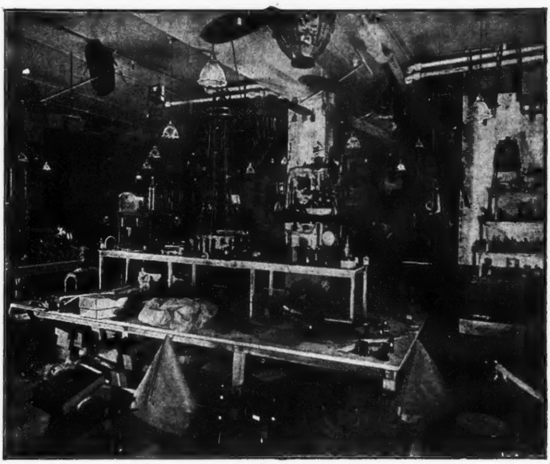
From the **British Thomson Houston Company** (77, Upper Thames Street, London, E.C.) a very complete and well-arranged list of MAZDA DRAWN WIRE LAMPS, comprising all standard types, as well as fancy lamps, candle, and twisted flame. A set of illustrations is given showing all the sizes of lamps to scale, and full particulars for all ranges. The list has a striking cover formed of the "Strength" show-card, an illustration of which we reproduced recently.

The "Regent" Gas Lamp for Shop Lighting.

Messrs. William Sugg & Co., Ltd (Regency Street, Westminster, S.W.), draw attention to the special features of their "REGENT" INVERTED INCANDESCENT GAS LAMPS, which make them suitable for shop lighting. The lamps can be fitted for any number of burners from one to nine, and gas and air regulators are provided. If it is desired to use only a limited number of burners after a given time in the evening, an additional cock can be provided for this purpose. Messrs. Sugg have a special line of steel parabolic reflecting shades which can be combined with the "Regent" lamp to form an effective unit for the exterior lighting of shops, and reflector signs can also be fitted for advertising purposes.

Departmental Store Lighting.

We reproduce here an illustration of the toy department of a large Sheffield Departmental Store, illuminated by means of "Tantalum" lamps in Holophane stiletto reflectors. The exceptional number of articles displayed therein, calculated to prevent prospective customers from properly considering the goods offered. With the perfect diffusion obtained from Holophane glassware, the lighting is evenly distributed and glare is completely eliminated.



which can be easily distinguished in the photograph, is a striking testimony to the efficiency of the lighting obtained, the photograph being taken with the lamps switched on. Illumination is undoubtedly essential for effective display, but glare is distinctly offensive, and is

Messrs. Siemens Bros., Dynamo Works, Limited, who supplied the lamps and glassware for the installation in question, would be pleased to place the services of their illuminating engineering dept., at the disposal of contractors interested in this system of illumination.

Shop Lighting by Welsbach High-Pressure Light.

The Welsbach Light Co., Ltd. (Welsbach House, Gray's Inn Road, London, W.C.), is equipped in a special degree for providing every conceivable means for shop lighting purposes; beginning with the smallest inverted incandescent gas burner giving about 75 candles, and ending with the largest unit that has yet been embodied in one single gas lamp, namely 4,500 c.-p. "Pharos" Welsbach high-pressure gas lamps.

It is the HIGH-PRESSURE LIGHT in particular to which we would like to draw our readers' attention, as it undoubtedly constitutes one of the most brilliant and economical illuminants of the present day. Our readers are recommended to inquire into the merits of the "Pharos" Welsbach high-pressure light, to see the lamp burning, and then to judge for themselves of its value.

The high-pressure gas system is well known in this country, but we doubt whether the peculiar advantages of high-pressure air are sufficiently appreciated by illuminating engineers, and this branch of lighting is now being specially exploited by the Welsbach Light Co. It stands to reason that mains containing high-pressure air constitute no danger in case of leakage, apart from the fact that a leak does not entail so much loss as with high-pressure gas.

Moreover, we understand that the special "Pharos" Welsbach switch apparatus in connexion with high-pressure air offers a variety of combinations in switching on or off of lamps or burners which, we are told, electricity cannot afford, except at exorbitant cost.

These few lines will, perhaps, awaken an interest amongst illuminating engineers as regards the "Pharos" Welsbach high-pressure light, and we are sure, if they inquire further into this system, they will learn details that are highly interesting.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

THE American *Illuminating Engineer* again contains a series of illustrated articles. One of the most striking of these deals with the Lighting of the People's Savings Bank at Cedar Rapids, Iowa, U.S. The architecture of the building seems to be on a decidedly novel plan, and the illumination is stated to be designed in accordance therewith. Indirect tungsten lamps in suitably coloured hanging bowls have been utilized, harmonizing with the colour-scheme of the different rooms; another feature is the provision of a frieze round the top of the room, on which landscapes are painted. Another article describes the lighting of a large publishing house, also by indirect tungsten lighting, and a third deals with the illumination on bowling alleys.

Several other articles and papers in the American magazines (*e.g.*, ROSCOE SCOTT, *Elec. Rev.*, N.Y., Feb. 3, and H. B. WHEELER, *ibid.*, Jan. 27) deal with Church Lighting; the introduction of electric lighting, even for spectacular effects, seems to be making headway, and the *Illuminating Engineer* (New York) contains an illustrated article containing photographs of a large cathedral, the exterior of which was outlined with incandescent lamps. The desirability of such displays, as a matter of taste, needs consideration.

Reference may also be made to a new German magazine *Licht und Lampe*, which contains quite a number of articles on lighting problems. W. BERTELSMANN gives the Distribution Curves of various multiple unit sources, G. ZEHDEN deals generally with the Hygienic Aspects of Lighting, and a third article discusses the part played by lighting fixtures and hanging chandeliers in rendering show windows attractive.

As regards articles of a more photometric kind we may note an interesting point raised by L. BELL (*Elec. World*, Jan. 27), who suggests that the effect on the eye in colour-photometry (Purkinje phenomena, &c.) is accentuated by simultaneous contrasts—*i.e.*, that such effects are greater when two coloured surfaces are placed side by side than they would be if these surfaces were examined separately. H. KRÜSS (*Zeitschr. f. Instrumentenkunde*, Jan.) describes A New Form of Spectro-Photometer equipped with flicker device, and readily applied to colour-mixing. TEICHMÜLLER (*J.f.G.*, Feb. 24) gives a summary of the existing Methods of Calculating Mean Spherical Candle-power, and then proceeds to describe a new form of special slide-rule for this purpose. W. J. CADY (*Illum. Eng.*, N.Y., Feb.) contributes a description of the Holophane photometric laboratory at Newark, U.S.

Data of a photometric and physical nature are also presented in a recent report of the Astrophysical Observatory of the Smithsonian Institute (Washington) where observations have been carried out on the nature of radiation and temperature of the sun, the absorption of light of different colours at high altitudes, the brightness of the sky at night time, &c.

ELECTRIC LIGHTING.

Very few contributions require notice this month. DARMOIS AND LEBLANC (*Z.f.B.*, Feb. 20) give a brief résumé of the various methods attempted in order to Improve the Spectrum of the Mercury lamp, by combination with incandescent lamps, introduction of gases and metals giving red spectrum lines in the tube, &c., the most hopeful device yet adopted being the rhodamine reflector. *The Electric Review* (Feb. 9) contains an abstract of a recent paper by G. CLAUDE describing the Neon Tube, which, however, has already been dealt with in this journal. HALVOISIN (*Electrician*, Feb. 9) discusses the ornamental design of arc lamps and posts for street lighting, some new types of lanterns used with the magnetite lamp being described.

The question of the "Over-shooting" Effect of Tungsten Lamps when first switched on is being discussed in the columns of *The Electrician*, and the *Zeitschrift für Beleuchtungswesen* continues its serial articles on the technicalities of metallic filament lamps construction.

GAS, OIL, ACETYLENE LIGHTING.

The British journals contain a number of notices of new lamps and mantles.

Particulars are given of the Pintsch high-pressure gas system, the low-pressure high c.-p. "Blanlite" lamps, and the "Strand" mantle. The latter novelty consists in a new method of weaving together loosely corrugated threads by which exceptional qualities as regards durability and plasticity are said to be secured.

The important contribution of C. O. Bond on American Gas Photometry is reproduced in *The Progressive Age.* Suggestions are made for the exact testing of gas lamps and mantles, &c., and special reference is made to the question of a calorific test of gas; opinions on this subject from authorities in this country, in Germany, and in Italy are quoted, the general view apparently being that the imposition of such a test is becoming more general, and will continue to do so. A summary is also given of the proceedings at the International Photometric Commission last year.

H. Wunderlich (*J.f.G.*, Feb. 24) discusses the design of posts for high candle-power gas lamps, pointing out the special difficulties in connexion with high-pressure air types, and how overcome; means are now generally provided enabling the lamps to be conveniently raised and lowered without interrupting the supply. The British gas journals also reproduce some designs of artistic lamp standards due to Alfred Stevens.

An event of considerable interest has been the annual meeting of the South Metropolitan Gas Co. (*J.G.L.*, Feb. 20; *G.W.*, Feb. 17). The reference to the benefits of co-partnership is timely at the present moment, when the relations between labour and capital are giving such concern. Allusion was also made to the new "Metro" burner, which has now been in operation for some time, and is said to be giving great satisfaction.

Recent numbers of the *Revue des Éclairages* as usual, contain a number of useful short articles on Acetylene matters, F. Granjon's Review of Novelties during the year (Jan. 30) deserving special notice. These novelties include various types of hand lamps, the use of the oxy-acetylene flame with a small pellet of rare earth material for lantern and projection work, and the use of a new substance—"catalysol"—which has the power of absorbing phosphoretted hydrogen, but is unaffected by acetylene. *Licht und Lampe* contains an interesting summary of progress in Incandescent Alcohol Lighting.

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Cady, W. J. A Commercial Photometric Laboratory (*Illum. Eng.*, N.Y., Feb.).

Calder, J. Illumination of Textile Mills (*Elec. World*, Jan. 22).

Coblentz, W. Special Energy Distribution of Neon and Helium (*Elec. World*, Feb. 17).

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Roscoe Scott. Electricity *versus* Wax in Religious Worship (*Elec. Review*, Feb. 3).

Ryan, W. D. Street-lighting (*Elec. Rev.*, N.Y., Jan. 27).

Sullivan, L. H. Lighting the People's Savings Bank, Cedar Rapids, Iowa, U.S.A. (*Illum. Eng.*, N.Y., Feb.).

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Lectures on Illuminating Engineering (*J.G.L.*, Jan. 30, Feb. 6, 13, 20).
Report of the Astrophysical Observatory of the Smithsonian Institute (Washington, U.S.A.).
Dekoration von Schaufenstern mit Beleuchtungskörpern (*Licht und Lampe*, Jan. 18).
On Opal Shades (*Elec. Review*, Feb. 16).

ELECTRIC LIGHTING.

Darmois, E., and Leblanc, M. Der Quecksilberbogen mit weissem Licht (*Z.f.B.*, Feb. 20).
Halvoisin, C. B. Arc Lamps for Ornamental Street Lighting (*Electrician*, Feb. 9).
Street Lighting in Watford (*Electrician*, Feb. 16).
The Overshooting of Metallic Filament Lamps (*Electrician*, Jan. 12, 16: Feb. 2).
Fortschritte in der Glühlampentechnik (*Z.f.B.*, Jan. 30).
Construction and Characteristics of the Neon Lamp (*Elec. Rev.*, Feb. 9).

GAS, OIL, AND ACETYLENE LIGHTING.

Blagg, P. Blackened Ceilings (*G.W.*, Feb. 24).
Bond, C. O. A Survey of American Gas Photometry (*Prog. Age*, Feb. 1).
Graujon. Les Nouveautés de l'Année [Acetylene] (*Rev. des Eclairages*, Jan. 30).
Wunderlich, H. Uber Lichtmaste für Pressluftlampen (*J.f.G.*, Feb. 24).
Zur Geschichte des Gasglühlichts (*Z.f.B.*, Feb. 10, 20).
The "Strand" Mantle and its Production (*J.G.L.*, Jan. 30; *G.W.*, Feb. 10).
The Pintsch High Pressure Gas System (*J.G.L.*, Feb. 6).
"Blanlite" High Power Lamps (*G.W.*, Feb. 3).
The Half-Yearly Meeting of the S. Metropolitan Gas Co. (*J.G.L.*, Feb. 20; *G.W.*, Feb. 17).
The Design of Decorative Lamp-pots (*G.W.*, Feb. 3).
Ueber die Fortschritte auf dem Gebiete der Spiritusbeleuchtung (*Licht und Lampe*, Jan. 18).
Prof. Lewes on Acetylene (*Acetylene*, Feb., 1912).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. f. G.—*Journal für Gasbeleuchtung.*
J. G. L.—*Journal of Gaslighting.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

Some Publications Received.

Engineering Standards Committee: Seventh Report on Work Accomplished.—Among other subjects, we notice a reference to the publication of the specification for bayonet socket lamp holders, and the Conference on International Electrical Standardization, which is in process of formation.

Scientific Illumination.—A booklet issued by the Macbeth-Evans Glass Company of Pittsburgh, U.S.A., with a view to showing the possibilities of modern illuminants when used to the best advantage. The book is produced in excellent style, contains a good deal of interesting matter, and is illustrated with a number of effective photographs.

Architects' and Builders' Pocket Book.—The 1912 edition of this pocket book, published by Messrs. E. & F. N. Spon, Ltd., is again divided into two sections, one dealing with memoranda and the other with prices. In the former section, we notice some useful data with regard to lighting by means of various illuminants.

The Junior Institution of Engineers: its Origin and Aims.—A neat little pamphlet giving a concise account of the objects of this Institution, and particulars of membership, &c.

Parasiten der Gasglühlichtbranche. By Dr. C. R. Böhm.

Sul rendimento di un fornello a gas. By Ing. M. Böhm (of Milan).

We also have to acknowledge the receipt of the following: *Journal of the Society of Architects, Journal of the Royal Society of Arts, Transactions of the South African Institute of Electrical Engineers, American Chemical Journal, Proceedings of the American Academy of Arts and Sciences, Transactions of the American Illuminating Engineering Society, Applied Science, Journal of the Electric Supply Publicity Committee.*

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ELECTRICITY · ACETYLENE · OIL · GAS

ILLUMINATING ENGINEER

Edited by

LEON · GASTER

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EDITORIAL.

The Lighting of Printing Works.

READERS will find on pp. 171-201 the papers read on the above subject by Mr. F. W. Goodenough and Mr. J. Eck at the last meeting of the Illuminating Engineering Society on March 19th. Besides being most interesting at the present moment, this unique series of data and photographs on the lighting of printing works will unquestionably prove valuable for future reference.

The papers will repay careful study, and, since restrictions of space necessitate our postponing the account of the discussion until the next number, members will doubtless be glad of this respite before sending in their remarks for publication.

This discussion should also lead people engaged in the printing trades to appreciate better the advantages of good illumination. There can be no doubt that in many cases the lighting conditions under which printing is carried on might be considerably improved — often by comparatively simple and inexpensive methods. It must also be remembered that conditions of artificial light are here exceptionally important in view of the fact that printing is so frequently carried out underground. Insufficient illumination, incorrectly placed lamps, and imperfectly shaded illuminants, all tell heavily on the quality of the work and the speed with which it is executed. It is notorious that printers are compelled by the exigencies of their calling to work at high pressure, a considerable amount of work almost inevitably being forced through at the last minute. Even in the case of a regularly published newspaper, where organization is carried to a fine art and everything should run like clockwork, the amount of time allowed for the various processes is sometimes cut very fine. A comparatively small defect may throw the whole system out of

gear, and a slight delay may have serious consequences.

It is now recognized that badly lighted plant is particularly liable to accidents. It cannot be properly attended to, and small defects are not recognized in time, thus paving the way for an ultimate breakdown. Seeing that the cost of proper illumination is small in comparison with the costly machinery served by it, it is surely false economy to grudge the necessary money for adequate lighting. These remarks apply equally well to the human machine. The difference between high-class and mediocre printing is chiefly a matter of attention to small details, the perception of small differences in sharpness, contrast in tone, &c. Naturally the operator needs good illumination to observe these details, and even if he achieves fair results in a poor light only does so by extra strain. Both as regards economy of effort and the welfare of the worker, therefore, good lighting is a necessity.

There is another section of a printing and publishing works in which good illumination is equally important, namely the considerable number of rooms in which the ordinary business and the editorial and literary work are carried on. Here, again, the work is of a character that imposes special efforts on the eyes. A man who is correcting proofs or examining bills most of the day deserves a particularly good illumination, and his eyes and nerves suffer if he does not receive it. In many cases it will doubtless be found that the lighting in this department is equally in need of supervision, and that the methods in use are wasteful and unscientific.

In what has been said above we have laid stress mainly on the advantages to be secured from good illumination. But it may also be pointed out that the possibilities of economy, owing to light being at present wastefully and extravagantly used, are often also well worth consideration. An examination of the papers by Mr. Goodenough and Mr. Eck proves that printing works exist using the same illuminant but consuming a very different amount of gas or electricity. In such cases the illuminating engineer, besides improving the illumination, can often secure a substantial saving.

To sum up, therefore, we can hardly imagine a class of business in which proper illumination is more important than in the printing trade, and we hope that the Society's work will go a long distance towards paving the way for the much-needed improvements.

The Illumination of Main Roads.

In a recent number of the *Westminster Gazette* (March 12th) some remarks appeared in the Motoring and Aviation section regarding the lighting of main roads. It was pointed out that while efforts are constantly being made to strengthen the lighting of important thoroughfares in the City, the main roads connecting large towns are often very poorly lighted. Moreover, it is added, even in cases in which very brilliant lighting is provided, not more light, but *more scientific illumination* is what is chiefly needed. The co-operation of motoring associations in dealing with this important question was suggested. The writer took the opportunity to send a communication to the *Westminster Gazette*(March 19th), recalling the discussion on some of these points following Dr. Hickman's paper before the Illuminating Engineering Society last November, and referring to the efforts towards a standard specification for street lighting now being made by the Joint Committee appointed in London for this purpose. It was also suggested that some of the money at present applied to the upkeep of road surfaces might fitly be devoted to experiments in lighting, and the hope was expressed that ultimately a central authority would be created, representing the traffic authorities and the

architectural and lighting experts, to investigate road lighting, and act as a permanent centre for information on these matters.

These suggestions received sympathetic consideration in the *Westminster Gazette* (March 21st), and it is evident that the matter is one that appeals to motorists. It will be generally admitted that one of the main purposes to be served by modern street illumination is the guidance of fast-moving traffic. Yet it cannot be said that the present methods are schemed out for this purpose. More brilliant illuminants have from time to time been substituted on the existing lamp-posts, but the scientific study of the direction and distribution of light, the avoidance of the effects of glare, &c., has hardly been touched as yet. It is true that tests on various forms of lamps are from time to time carried out in our streets, but they are devised mainly with a view to comparative economy, and really radical experiments and innovations (such as must always be the forerunners of genuine improvement) are rarely attempted. Moreover, the fact of the lighting of London resting in the hands of so many local authorities leads to much repetition of experiments and to chaotic results, each district adopting certain forms of illuminants which possibly suit their local requirements, but are not necessarily the best for guiding the traffic in our main arteries.

We feel sure that a series of experiments on the lines suggested in the *Westminster Gazette* would be most useful. They might well be undertaken by a committee on which motorists, lighting experts, borough surveyors, and the traffic authorities were represented, and we feel sure that the Illuminating Engineering Society would be glad to render any possible assistance.

On one point we feel confident. Such alterations as are made in methods of lighting in the future will be directed towards the suppression of the effects of dazzle and glare which the present use of powerful imperfectly screened sources of light are apt to produce.

The Hygienic Aspects of Lighting.

During the past few weeks there have been published several articles and papers dealing with the hygienic aspects of lighting, and it is instructive to notice how this point is now receiving much of the attention formerly concentrated on relative costs. We observe, for example, in a recent number of the *Times Engineering Supplement*, a popular article referring to the formation of the Committee on Hygienic Aspects of Lighting by the French Government. *Licht und Lampe*, a recently issued German publication dealing with lighting, has also an article on these matters.

On March 11th a paper was read by Mr. Fraser, A.R.I.B.A., before the Institute of Sanitary Engineers, on 'The Modern House,' in which reference to the question of lighting was made. We are glad to notice the emphasis which the author lays on good illumination—both day and artificial.

We notice, too, that a meeting at the Guildhall, on March 28th, was devoted to the consideration of the now familiar "daylight scheme" of arranging the business hours of the day so as to secure a maximum of natural light. In passing it may be suggested that the advocates of this cause, as well as illuminating engineers, might well spend a little time on the question of the best methods of *utilising daylight*, so as to secure the most ideal conditions of illumination.

It is remarkable that statements to the effect that gas is better hygienically than electric lighting (or vice versa) are constantly made in papers by many sanitary engineers and architects, but not much evidence is brought forward on this all-important question. General contentions of this

kind are almost invariably seized upon and quoted by the representatives of the illuminant they happen to favour. We should very much like to see a few complete series of impartial inquiries into the hygienic qualities of various illuminants carried out. But until then we feel bound to treat these contradictory claims regarding the influence of various lamps on eyesight with considerable reserve.

There is one obvious factor which is often lost sight of by writers who are not very familiar with illuminating engineering, *i.e.*, the consequences of the manner in which the illuminant is used. As we have often pointed out, a brilliant source placed within the direct view of the user so as to dazzle the eyes, whether it be an electric glow lamp or an incandescent mantle, is bound to be prejudicial; but whether there is any marked hygienic difference between the light of the illuminants, *when properly used and shaded*, is quite another matter. This is a point that cannot be said to have been properly investigated as yet, and is one on which the enlightened illuminating engineer may be advised to withhold his judgment for the present.

The Effect of Illuminants on Vegetation and Animal Life.

The broad question of the effect of light on plant and animal life (quite apart from its effect on vision) also seems ripe for more comprehensive study. From time to time one gets glimpses of the fascinating work being carried out in many fields by independent experimenters, but the results often seem curiously inconsistent to the outside observer. The subject is complicated by the fact that not only the intensity, but the colour of the light has to be considered. The problem is essentially one for the physicist and physiologist to consider together.

In the course of a paper before the Royal Society of Arts on March 6th, Mr. T. Thorne Baker alluded to some researches on the effect of light on bacteria. Violet and orange light, he suggested, had the greatest effect, the intermediate yellow-green rays having comparatively little influence. It seems to be now well recognized that excess of ultra-violet rays (at all events as regards bacteria) has a destructive effect.

Another recent paper before the Royal Society of Arts on March 20th, that by Mr. F. Martin Duncan on the work of the Marine Biological Association, dealt with some researches of Dr. E. J. Allen and Mr. E. W. Nelson on 'Mackerel and Sunshine.' It appears that the number of mackerel in a particular year can be shown to depend to a great extent on the development of a vegetable material, the "copepod plankton," on which they feed. Now the growth of this food appears to be exceptionally favoured by abundant sunshine. The result is that, to use the lecturer's words, "a fundamental correlation exists between the abundance of mackerel in May and the amount of bright sunshine during the earlier months of the year. Indeed, when plotted out, the extreme closeness of agreement between the sunshine curve and the mackerel capture is quite surprising."

This is doubtless only one of many phenomena which are known to bear out the close connexion between abundance of light and the growth of vegetable and animal organisms. Is it not probable that light is equally important in its influence on human life?

That such effects exist seems to be fully recognized by the medical profession. Abundance of light, as well as fresh air, is believed to be a valuable weapon in combating tuberculosis. Now that so much money is to be spent in sanatoria for consumptives throughout the country the effect of light on health would form a most valuable subject for research.

LEON GASTER.

Review of Contents of this Issue.

A CONSIDERABLE section of the magazine this month is devoted to the *Transactions* of the Illuminating Engineering Society, and, as some of this matter has already been dealt with in abstract, the Review of Contents is somewhat curtailed.

On the next page will be found two short notes, one of which describes an interesting application of indirect lighting to a building having a large dome, while the other suggests a connexion between Mr. Asquith's recent fall on the steps of the Foreign Office and the inadequate lighting at that spot.

At the beginning of the *Transactions* of the **Illuminating Engineering Society** (p. 169) will be found a brief report of the meeting on March 19th, with a summary of the discussion which took place on the 'Lighting of Printing Works.' This is followed by a list of new members of the Society.

The paper by MR. F. W. GOODENOUGH on **The Illumination of Printing Works by Gas** begins on p. 171. The paper consists mainly of a comprehensive collection of data with regard to the lighting of various departments in several well-known printing works, much of the information being arranged in the form of tables and diagrams. Special attention is naturally given to the illumination of composing frames, and it is pointed out that this class of work not only requires an ample quantity of light, but light of the right quality, *i.e.*, with a high "visual value." The economy to be obtained by the free use of whitewash on the walls and ceilings is clearly shown in a table dealing with surface brightness.

In connexion with the lighting of printing machines, several points are brought out, such as the difficulty of vibration due to moving machinery, the lack of ordered arrangement of the machines, and the necessity for providing special lights to facilitate the inspection and repair of the hidden parts of the machine. The paper is illustrated by a number of photographs exhibiting the special features referred to.

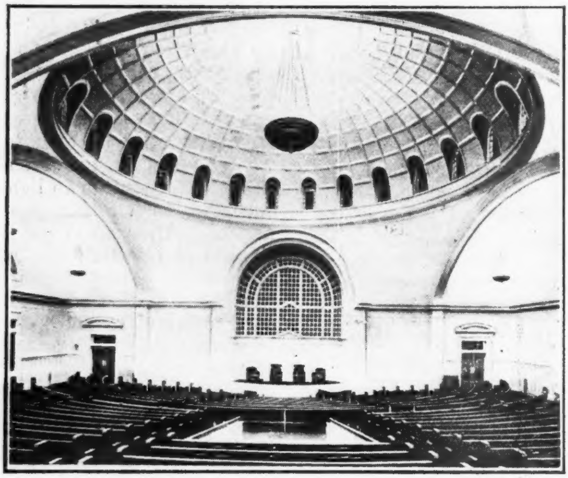
On p. 185 MR. JUSTUS ECK deals with the **Illumination of Printing Works by Electricity.** The paper is devoted mainly to the lighting of newspaper printing offices, and the author points out that it is here, where the work is done so largely by artificial light, and where time-saving is of such importance, that close attention to lighting may be expected to effect considerable economies. After some general observations, the question of type-setting is dealt with, attention being drawn to the local lighting required in linotype machines and to the use of reflectors to obtain this. A comparison of the efficiencies of various illuminants in composing rooms is given in tabular form, and the illumination intensities by daylight and by artificial light are compared. After a brief reference to the type-foundry, the author passes on to the subject of printing proper. He points out the difficulty of lighting a large rotary press, and suggests as the best solution some form of indirect lighting, with supplementary local lights for important parts of the machine. The necessity for a colour-true lamp when lighting colour printing machines, so that inks may be matched by night as well as by day, is mentioned. In conclusion, the author deals briefly with the lighting of dispatching rooms and some of the other less-important departments of printing works. The paper is fully illustrated with photographs, the majority of which are taken by artificial light.

Following Mr. Eck's paper is the complete discussion on **Shop Lighting,** which includes several communications received since the meeting, and contains the replies of the authors, MESSRS. N. W. PRANGNELL AND A. E. BROADBERRY.

At the conclusion of the magazine will be found the usual **Trade Notes** and **Review of the Technical Press.**

Indirect Lighting of a Large Dome.

An interesting application of the indirect system to the lighting of a large domed interior is shown in the accompanying illustration. The dome in question, which is one of the principal features of the eighth Church of Christ Scientist in Chicago, is 60 ft. in diameter, and rises to a height of 50 ft. from the floor. One single central fitting is responsible for the illumination of this dome, and it is necessarily of considerable dimensions. It is formed of a white bowl, 7 ft. 6 in. in diameter, containing twenty 250-watt tungsten lamps, each equipped with its own silvered reflector. The lamps are all on separate circuits, controlled from a switchboard behind the rostrum. By this means the intensity of illumination in the building can be very easily varied as required. For cleaning or renewing the lamps, the whole fixture can be lowered to the ground by means of a worm gear. For the above particulars and illustration we are indebted to the courtesy of *The Electrical World*.



Mr. Asquith's Mishap—Due to Poor Illumination.

Lloyd's Weekly News comments as follows upon the mishap which occurred to Mr. Asquith, who slipped on the steps when leaving the Foreign Office on Thursday, February 22nd, and fell, although fortunately without serious consequences :—

"The corner is quite inadequately lighted, and Mr. Asquith had evidently forgotten for the moment the existence of the step, familiar as he must be with the immediate locality."

The incident only shows the necessity for proper illumination on steps and stairs, and the ease with which defects of this kind may lead to accidents. In the case of a long and steep flight of steps the results of such a slip might easily prove serious, especially so in the case of a workman carrying a heavy load. In many factories ill-lighted stairs could doubtless still be found, and the above incident suggests that the lighting of the thresholds of our public buildings would often be the better for more careful supervision. Not only should the actual illumination on the step be sufficient, but the lamp giving the illumination should be well out of the range of view of persons leaving the building, otherwise it may dazzle their eyes, and, making the steps below indistinguishable, do more harm than good.

TRANSACTIONS
OF
The Illuminating Engineering Society

(Founded in London, 1909.)

(The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.)

The Lighting of Printing Works.

A MEETING of the Society was held on March 19th, 1912, MR. HAYDN T. HARRISON (Vice-Chairman of Council) being in the chair.

The minutes of the last meeting having been taken as read, the Chairman called upon the Hon. Secretary to read again the names of applicants for membership presented at the previous meeting, who were then formally declared members of the Society. The names of applicants for membership received since the last meeting were also read out for the first time.

The Chairman, in his introductory remarks, expressed the hope that those who wished to join in the discussion would send in their names immediately after the papers had been read. He then called upon MR. F. W. GOODENOUGH to read his paper on 'The Illumination of Printing Works by Gas.' This was followed by a paper by MR. JUSTUS ECK on 'The Illumination of Printing Works by Electricity.' (These papers will be found *in extenso* on pp. 171–200).

The Chairman, before declaring the subject open for discussion, said that they were glad to welcome to the meeting representatives of various printers' associations, and he hoped that they would have the benefit of hearing the views of some of these gentlemen on the lighting of their works. As no names had yet been sent in, however, he would ask Mr. Frank Bailey to open the discussion.

MR. F. BAILEY said that the authors of the papers ought to be specially congratulated on the beautiful set of illustrations they had thrown on the screen. He would like to ask them whether, in the course of their visits to the various works, they had heard any complaints on the score of bad effect on eyes or contamination of the atmosphere. He felt that the hygienic aspect of the question was an important one.

MR. F. W. WILLCOX was glad that bad examples of lighting had been shown as well as good, because it was only by studying the former that the requirements of really good lighting could be discovered. The need of the illuminating engineer was clearly shown all through the papers, and the case cited by Mr. Eck, of greatly improved light due to the use of proper reflectors, was only one of many. There was a general lack of knowledge with respect to reflectors. The value of indirect arc lighting had been clearly demonstrated, but he would remind Mr. Eck that there was no reason why the same effect should not be obtained with glow lamps on the indirect system.

MR. P. J. WALDRAM referred to the importance of a high light in daylight illumination, as instanced by the use of skylights in composing rooms, and he thought that the same principle should be applied in artificial lighting, *i.e.*, to light from above whenever possible. From this point of view, much could be said in favour of indirect lighting.

MR. T. E. RITCHIE mentioned a difficulty that was found when using indirect lighting fixtures of the bowl type in rooms where rotary presses were at work, viz., the deposit of a film of ink, which was constantly falling on all upturned surfaces.

MR. M. FOULDS doubted whether the spectrum of the light employed was of much importance in printing works, except where colour printing was carried out. He thought that complete absence of glare was quite as much worth attention as the nature of the illuminant.

MR. G. MASCORD, speaking as one actually connected with printing works, said that, although in the early days of gas lighting he had known rather high temperatures in works, the present-day improvements had made it very difficult to decide which was the better illuminant to use—gas or electricity. He gave some particulars of the lighting of the works he was connected with, and referred to the prejudice which existed among printers against any innovation, as was exemplified by his own experience in introducing mercury vapour lamps.

MR. V. H. MACKINNEY laid stress on the tendency to vibration in printing works, &c., which must be borne in mind. In connexion with lighting for compositors, he thought that light sources should be judged from a standard of "visual power," a factor which was becoming increasingly recognized.

MR. L. GASTER mentioned that several printers' societies and associations had been invited to send representatives to the meeting. For example, he hoped that the Secretary of the Master Printers' Association would be present, and the Secretary of the London Society of Compositors had written expressing regret that a meeting of their own would prevent him from doing so. Mr. Gaster also drew Mr. Bailey's attention to the inquiry which was being carried out in Milan with regard to the effect of light on eyesight in connexion with printing works, and especially to the work of Dr. L. Carozzi in this respect.

The Chairman then called on Mr. Goodenough and Mr. Eck to reply briefly to some of the points raised in the discussion, after which a hearty vote of thanks was accorded to the authors.

The next meeting was announced to take place on April 16th, when papers would be read on 'Private House Lighting,' Mr. W. H. Y. Webber dealing with gas lighting, and Mr. W. R. Rawlirgs with electric lighting.

[*It is proposed to deal ful y with the discussion of the papers by Mr. Eck and Mr. Goodenough in the next number. Members and others interested are invited to send in contributions in writing to be included in the published account. Such contributions should reach us by April 10th.*—ED.]

NEW MEMBERS OF THE SOCIETY.

The names of the applicants for membership, read out at the previous meeting on February 20th, were formally announced for the second time, and these gentlemen were declared Members of the Illuminating Engineering Society.*

In addition the names of the following gentlemen have been duly submitted and approved by the Council, and were read out by the Hon. Secretary at the meeting of the Society on March 19th :—

Members :—

Eastman, R.	Lighting Expert to the British Thomson-Houston Co., National Buildings, Parsonage, Manchester.
Ford, W.	Divisional Inspector, Gas Light and Coke Co., 148, Goswell Road, London, E.C.
Holt, E. C.	Divisional Inspector, Gas Light and Coke Co., 2, Gainsborough Road, Leytonstone, Essex.
Walker, F. J.	Managing Director, St. James's and Pall Mall Electric Supply Co., 19, Carnaby Street, Golden Square, W.
Webber, W. H. Y.	Gas Engineer, Staff Instructor to the Gas Light and Coke Co., Isca, Udney Park, Teddington.
Wingate, M. F.	Optician, 35A, Welbeck Street, London, W.

* See *Illum. Eng.*, Lond., March, 1912, p. 137.

The Illumination of Printing Works by Gas.

By F. W. Goodenough (Mem. Inst. Gas Engineers).

[Paper presented at the meeting of the Illuminating Engineering Society, held at the House of the Royal Society of Arts (John Street, Adelphi, London), on Tuesday, March 19th, 1912, at 8 P.M.]

In this paper I have endeavoured to place before you some data which have been obtained respecting a few gas lighting installations in printing works.

I would like, however, to point out at once that the results are not put forward as bearing on every aspect of the many-sided problem under discussion. They are merely a few notes of some observations that have been made from time to time, and which may be of some interest to the members of this Society.

Circumstances vary so much that it would need a very extensive investigation to take every aspect of the question into account.

It is doubtful if there exists another form of industry in which good lighting has more effect on the successful running of the concern than is the case in the printing trade. The work carried on and the conditions that have to be met are of a peculiar character, and one is sometimes inclined to think that the owners would find great advantages from removing or reconstructing a works altogether. It too often happens that printing works are surrounded by high buildings which blot out the sky, thus necessitating the almost continuous use of artificial light.

Another constructional feature that is frequently encountered is the comparative lowness of the ceilings which is by no means an advantage from an illuminating engineering point of view.

It is worthy of note, however, that most printing works managers perceive the advantages to be derived from the generous use of whitewash, which is cheap, and conduces to bright and sanitary conditions for the workmen.

Many printing establishments, of course find it necessary to do a large amount of work during the night. In such cases it is of great importance that care should be bestowed upon the artificial lighting installation.

Again, the work is often carried out against time, which further emphasizes the need for good lighting. On one occasion I saw a number of men setting up a paragraph which was to be used in a newspaper copies of which had to be despatched by a train leaving London about forty minutes later, the terminus being about a mile away. This will give an idea of the rate at which work is done in newspaper printing works.

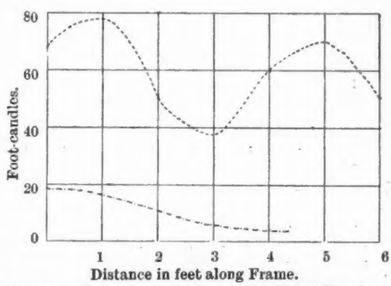


Fig. 1.—Showing variation of daylight illumination on two composing frames in the same room (Solicitors' Law Stationery Society).

As bearing on the question of the deficiency of natural lighting that is sometimes met with, Fig. 1 is interesting. The two compositors' frames alluded to were in the same room. In one case a fair amount of sky area was visible, but in the other case the amount was very small. The observations were made at midday, with a fairly bright sky and on the actual working surfaces of the frames.

Compositors were working at both frames, and appeared to be quite able to do their work satisfactorily. I just mention this in passing as an interesting practical example of the great adaptive power of the eye; it is no part of this

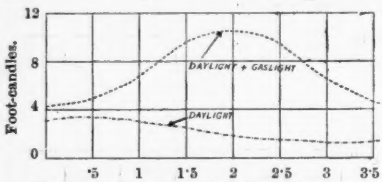
paper to deal with the problem of daylight illumination.

Again, Fig. 2A shows the illumination found upon the inspection board of a ruling machine in a basement workroom. Artificial illumination was, of course, continuously employed.

The style of gas lighting that has found great favour in printing works is what has been called "point lighting," *i.e.*, by means of small units under separate control, and it appears that the system is justified on the following grounds :—

(1) The special requirements of each particular machine and workman may be met to some extent.

(2) Out of a number of machines or benches it may happen that only one is in use. Point lighting conduces to economy in gas consumption by making it possible for lamps that are not required to be extinguished.



Distance in feet along centre of Ruling Board.

FIG. 2A. — Illumination of Ruling Board — Obscured Globe (Solicitors' Law Stationery Society).

In exploring the illumination of any works it is interesting and highly instructive to ascertain the ideas of the workmen in regard to the lighting. One is sometimes a little startled by a workman stating that he prefers to see a bright light, and will use clear glass in preference to the obscured type. On the other hand, many workmen endeavour to supply the omission of the lighting engineer by attaching little aprons of paper to the edge of the reflector to screen off the glare. Considerable ingenuity is sometimes exercised by the men in their endeavour to make good the omission.

It sometimes happens that sufficient care is not exercised to the best form of reflector for a given purpose.

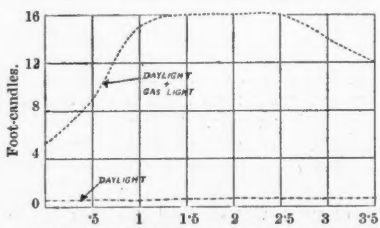
A comparison from this point of view is seen in the two photographs (Figs. 3 and 4) taken at the premises of Cassell & Co. and the Solicitors' Law Stationery Society respectively. Fig. 4 shows what is clearly the better installation of the two, because it combines good illumination with a total absence of glare. Glare such as that shown in Fig. 3 is not serious, but it should, I think, be avoided, especially as this can easily be done.

Illumination of Composing Frames.

A summary of the results obtained in several composing rooms is given in Table I.

The illumination of composing frames is probably the most important aspect of printing works lighting. The work that is performed there and on the "stones" demands a high visual effort, and therefore good and suitable lighting.

One is often struck by the great difficulty in defining what "adequate illumination" should be. The difficulty is, of course, due to the great power of adaptation of the eye and to the variety of work carried out. Fig. 1



Distance in feet along centre of Ruling Board.

FIG. 2B.—Illumination of Ruling Board—Clear Globe (Solicitors' Law Stationery Society).

illustrates this point very well. Fig. 5 is a further illustration; it shows how the illumination on various parts of a composing frame may vary without causing any inconvenience to the operator. In fact, one is quite unconscious of the variation, except by instrumental aid.

This interesting phenomenon raises the question of how far the foot-candle value of illumination can be taken as a criterion of the "visual value."

It is, of course, quite well known that the "visual value" of the illumination of any particular object is largely dependent on the comparative brightness of the adjacent surfaces, and where sharp differences occur the

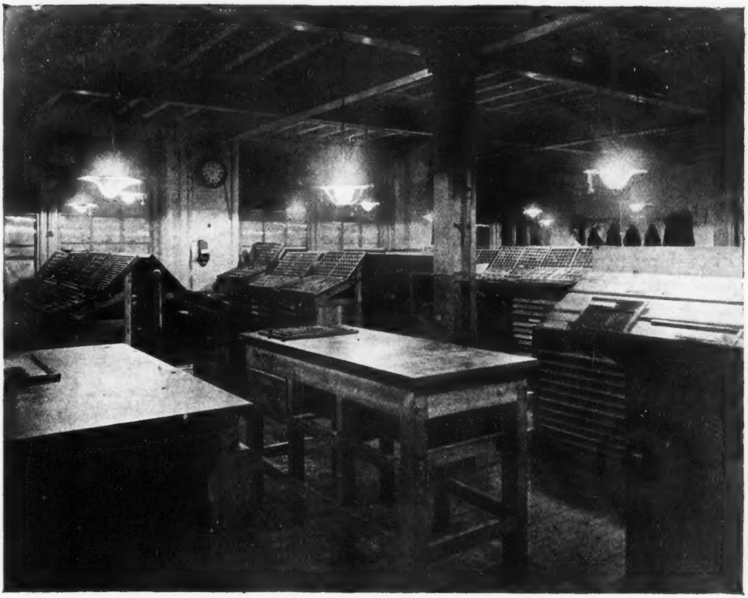


FIG 3.—Illumination of Composing Frames—Solicitors' Law Stationery Society.

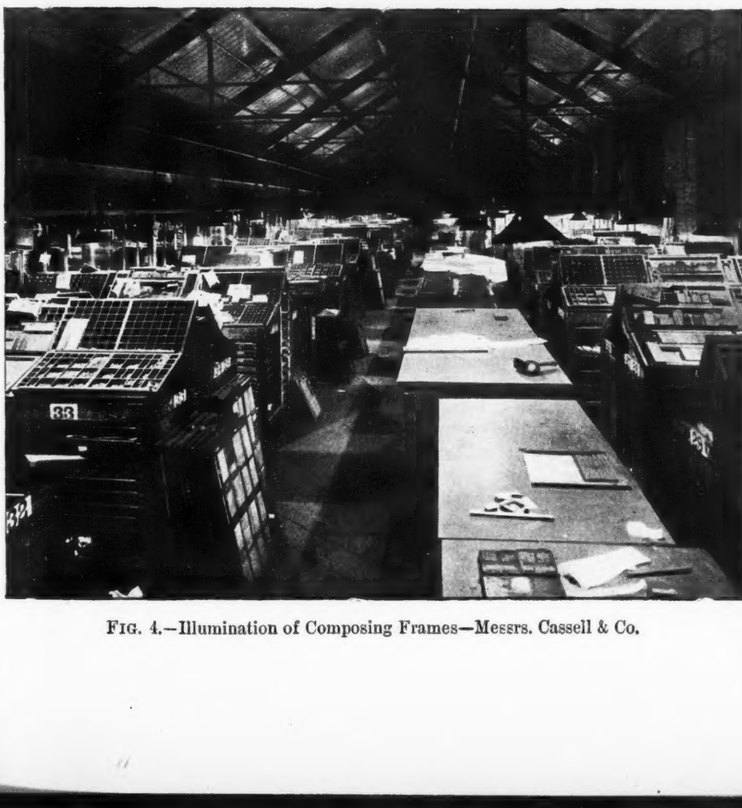


FIG. 4.—Illumination of Composing Frames—Messrs. Cassell & Co.

"visual value" of the lower illumination is depreciated. It is therefore insufficient to specify a certain minimum illumination as necessary unless it is qualified in some way to prevent the occurrence of sharp contrasts.

Although some of the illumination curves given in the paper show marked inflections, the grading was such as to prevent apparent contrast, and work could be satisfactorily carried out on any part of the frame.

On looking round various works one is often struck by the high illumination values found, and one feels inclined to reflect on the huge amount of light that must sometimes be wasted.

Figs. 6 and 7 show a number of curves illustrating the illumination on various parts of the working surface of composing frames. In no case was it felt that the illumination was too low, but it is possible that where the value rises above, say, 8 foot-candles, it might be reduced without impairing the "visual value" of the lighting.

The compositor generally places his galley of type at the extreme end of the composing frame.

Composing frames are usually arranged on one of two systems, viz., either the single or the back-to-back systems, the latter being the most common, because of its effecting economy in light and floor space.

The two systems are illustrated in Figs. 3, 4, 4A, and 8.

As will be seen, the back-to-back system admits of two frames being illuminated by one source of light. On the other hand, the single system (Fig. 8) requires one light source for each frame (unless a general scheme is adopted) and a higher consumption of energy per square foot, although the distribution of illumination over the working surface is rather better than with the back-to-back system.

Comparing the illumination of the frames at Messrs. Eyre & Spottiswoode's works with that found at Messrs. Mathieson & Sons, in each case the lighting was by upright incandescent burners, and the shades of approximately the same shape. The following figures represent the comparative result. (See p. 176 "A.")

It will be seen that the gas consumption was twice as great with the single as with the back-to-back frames, and the resultant illumination was higher in a similar proportion, so that the practical efficiency was approximately the same in each case. The higher illumination was also accompanied by a lower diversity coefficient, but the difference is of no practical importance.

Judged from a practical standpoint, both systems would probably be regarded as satisfactory.

TABLE I.—OBSERVATIONS IN VARIOUS COMPOSING ROOMS.

Description of Works.	Floor Area.	* Fitting used.		* Gas Consumption.		Illumination on Working Surfaces. Foot-Candles			Length of Frame.
	Square feet.	No.	Description.	Total c. ft. per hour.	Per foot length of Frame.	Upper Surface.	Lower Surface.	Average.	Feet.
					c. ft. per hour.				
Polytechnic Printing School	{	3	"Nico" Burners	10·5	0·91	14·2	14·8	14·5	11½
		2	do. do.	7·0	0·56	8·5	10·3	9·4	12½
Messrs. Bradbury Agnew...		1	H.P. Inverted	2·0	0·33	7·1	7·8	7·45	6
Cassell's... ...		2	H.P. do.	4·0	0·47	5·6	6·2	5·9	8½
Solicitors' Law Stationery Society ...	3110	1	H.P. do.	2·0	0·33	6·8	6·7	6·75	6
Eyre & Spottiswoode ...	1836	1	L.P. Upright	4·0	0·67	3·7	4·5	4·1	6
Messrs. Mathieson & Sons ...		1	do. do.	4·0	0·67	7·4	7·0	7·2	6

* Calculated on one Frame.

Both high- and low-pressure systems of lighting are in use in printing works installations, and it may be interesting to compare a few of them.

three times as efficient as the low-pressure upright, a result that might, of course, have been anticipated from known data.

FIG. 4A.—Illumination of Composing Frames—Back-to-back arrangement.

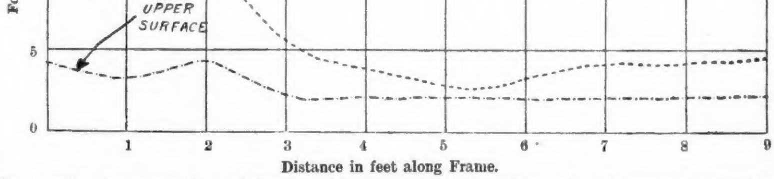


FIG. 5.—Showing comparison of Upper and Lower surfaces of a Composing Frame under Daylight Illumination (Solicitors' Law Stationery Society).

The following are data relating to a few typical examples. (See p. 176 "B.")

It therefore appears that the high-pressure inverted system is about

Against this must be set the cost of compression and a slightly higher cost of maintenance but these do not

seriously discount the economy of the high pressure system.

The efficiency at Cassell's was rather low compared with that found on the other high-pressure installations. This was partly due to the gas consumption per unit length of frame being rather high, as shown in the following summary:—

Works.	Gas used for each frame (cub. ft. p. h.)	Length of frame (feet.)
Cassell's	4	8½
Bradbury Agnew's and Solicitors' Law Soc.	2	6

The amount of light over each frame at Cassell's was sufficient to illuminate adequately a frame about 12 ft. long, so that much of the light was lost, as far as the frame itself was concerned.

The illumination curves obtained at the Printing School of the Regent Street Polytechnic form an excellent illustration of the need for some attempt at standardization of illumination values.

It appears that, owing to the low cost of production of light by modern methods, there is a great tendency to over-illuminate, although this too frequently results in a reduction of "seeing power."

Illumination of Stones.

What are technically called "stones" are flat faces situated near the composing frames. The "set-up" type is placed upon the "stones" before being dispatched to the machine.

As in the case of composing frames, a variety of results have been found. Figure 9 shows the kind of illumination found in a few gas-lighted installations, all of which might be described as satisfactory from a practical point of view, although there can be very little doubt that some of the maxima could be reduced without affecting the "visual value" of the general illumination.

It is probably more important that the illumination of the "stones" should be well done than is the case with the composing frames, because in the latter instance the work done is largely of a mechanical nature, owing to the type being arranged in a definite and well-known order. A compositor

A.

Works.	Arrangement.	Gas per hour per sq. ft. of frame.	Illumination. Foot-Candles. Max.	Min.	Aver.	Ratio. Max./Min.
		c. ft.				
Eyre & Spottiswoode's	Back to Back	·134	6·6	2·5	4·1	2·64
Mathieson & Sons ...	Single	·267	10·0	4·6	7·22	2·17

B.

Works	Gas per hour per sq. ft. of frame. (cub. ft.)	Illumination Foot-Candles. Max.	Min.	Average	Diversity Co-efficiency	Lumen-hours on working surface per ft. gas.
Eyre & Spottiswoode's low-press. upright. ...	·134	6·6	2·5	4·1	2·64	30·7
Bradbury, Agnew's high-press. inverted	·067	12·0	2·9	7·45	4·14	112
Cassell's high-press. inverted	·094	12·0	3·7	5·90	3·25	62·7
Solicitors' Law Stationery Soc. high-press. inverted	·067	12·6	3·3	6·75	3·82	101
Mathieson & Sons low-press. upright ...	·267	10·0	4·6	7·22	2·17	27

FIG 8.—Illumination of Composing Frames—Arrangement in single rows.

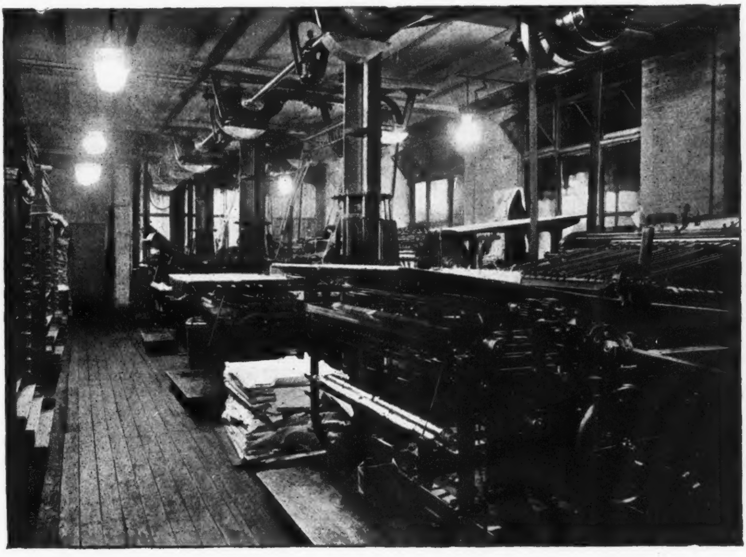


FIG. 10.—Illumination of Printing Machines at Messrs. Eyre and Spottiswoode's.

Works.	Area of "Stone" sq. ft.	Illumination. Foot-candles. Max.	Min.	Average
Messrs. Cassell & Co.	33	14·0	4·0	8·4
Messrs. Mathieson & Sons ...	10·8	7·7	2·8	4·65
Messrs. Mathieson & Sons ...	16·9	5·6	3·4	4·2
Messrs. Bradbury Agnew ...	24·5	10·0	8·0	9·3
Messrs. Eyre & Spottiswoode	26·8	19·0	7·3	14·2

can find the piece he wants without looking for it.

On the other hand, the final correction of the set-up type is done on the "stones," and this undoubtedly requires a high visual effort, and therefore good illumination.

Brightness of Walls.

This quantity, no doubt, has some influence on the effectiveness or visual value of a given scheme of lighting.

Some observations were made in

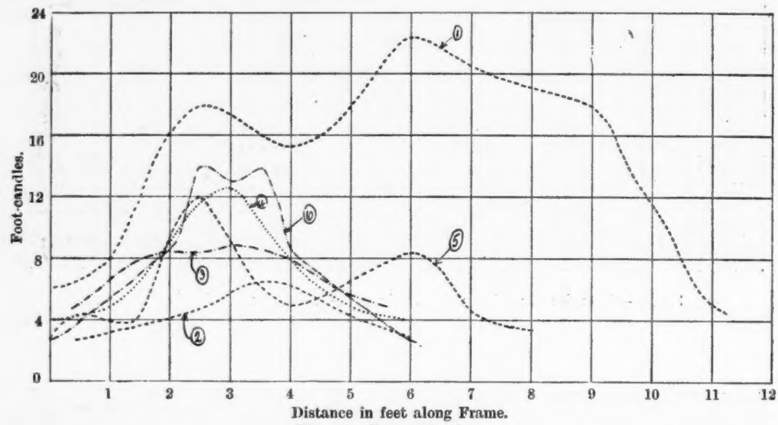


FIG. 6.—Lower Surfaces.

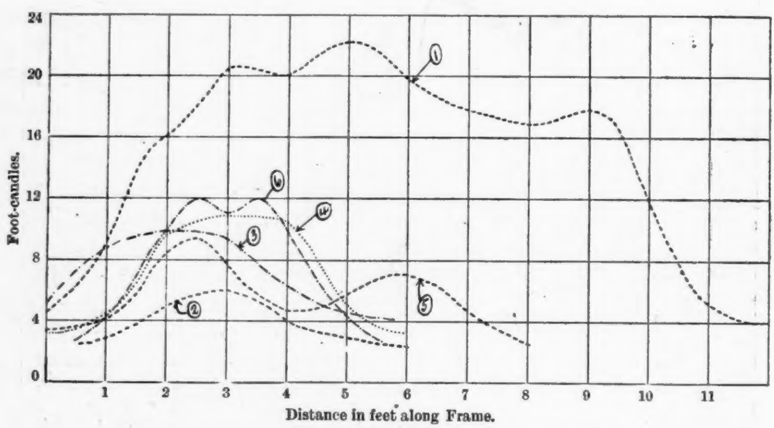


FIG. 7.—Upper Surfaces.

Illumination of Composing Frames in various Printing Works.

No. 1. Regent St. Polytechnic.
No. 2. Eyre & Spottiswoode.
No. 3. Mathieson & Sons.
No. 4. Solicitors' Law Stationery Society
No. 5. Cassell & Co.
No. 6. Bradbury, Agnew & Co.

FIG. 11.—Illumination of Printing Machines at Messrs. Eyre and Spottiswoode's.

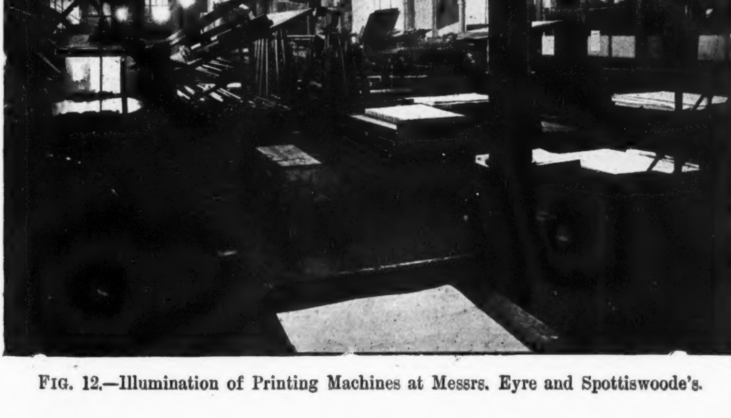


FIG. 12.—Illumination of Printing Machines at Messrs. Eyre and Spottiswoode's.

various works, and the results are tabulated in the following summary :—

Works.	Room.	Surface brightness of wall (taken within 6 ft. above the floor unless otherwise stated).	Description of wall.
		ft. candles	
Solicitors' Law Stationery Soc.	Litho Stamping	3·7 to 5·1	clean white-wash
,, ,,		3·4 to 4·8	,,
,, ,,	Composing	3·8 (daylight)	,,
Mathieson's ...	,,	1·4 to 2·4 / ·14 to ·2 nr. ceiling	fairly clean
Eyre & Spottiswoode's ...	Machine	·8 to 1·0	dirty
,, ,,	,,	·44 to ·74 (ceiling)	white-wash
,, ,,	Composing	·48 to 3·0	clean ,,

The figures refer to gas lighting unless otherwise stated.

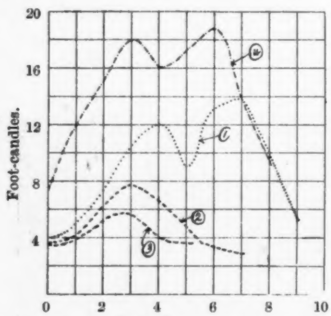


FIG. 9.—Illumination of "Stones" in various Works.

No. 1. Cassell & Co. No. 3. Mathieson & Sons.
No. 2. Mathieson & Sons. No. 4. Eyre & Spottiswoode.

Should any proposals ever be made for standardising the artificial lighting of workshops — *i.e.*, by prescribing desirable maxima and minima—the question of the colour and cleanliness of the surfaces which bound the workshop would have to be taken into account. The difference between clean and dirty whitewashed walls is very considerable.

Reading Rooms.

Generally speaking, the values found in the reading rooms were rather high, due to the fact that the surfaces to be illuminated were comparatively small, so that, with even a small unit of light, a sufficiency of illumination was easily be secured.

The following summary gives some of the data obtained :—

READING ROOMS.

Works.	Illumination Foot-candles. Max.	Min.	Aver.	System of Lighting.
Messrs. Cassell & Co.	13·0	5·0	8·2	high power inverted
Messrs. Eyre & Spottiswoode	15·0	8·0	10·0	low power upright
Messrs. Bradbury, Agnew	15·0	8·4	10·5	high power inverted

Machine Rooms.

A summary of the results obtained in several machine rooms is given in Table II.

It would appear that the following are the principal points that require consideration:

(1) The "laying on" and "taking off" boards of the machines need to be adequately illuminated.

(2) A good general illumination is needed to facilitate the transfer of the printed sheets to the benches for inspection.

(3) Means for illuminating the under parts of the machinery for inspection purposes should be provided.

The working surfaces referred to in the summary of machine shops are, in the case of printing machines, assumed to be the "laying-on" and "taking-off" boards. The arrangement of the units in the machine shops of Messrs. Eyre & Spottiswoode (shown in Figs. 10, 11, and 12) appears to be very satisfactory.

The illumination is due to three-mantle and one-mantle inverted units fitted with diffusing globes. The arrangement is clearly shown in the photographs, and the photometric data are given in the table relating to machine rooms.

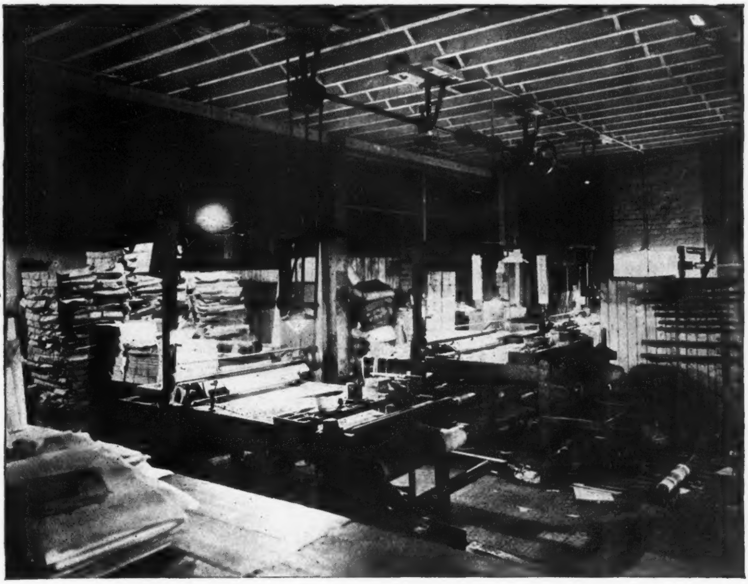


FIG. 13.—Illumination of Ruling Machines (Solicitors' Law Stationery Society).

FIG. 15.—Illumination of Litho. Room at the Solicitors' Law Stationery Society.

The machines at this works are of a large type, for which the scheme of lighting seems very well suited.

It may be interesting to mention here that it is sometimes necessary to provide against the vibration set up by the moving machinery, otherwise an excessive mortality of mantles would result. Efficient appliances are available which prevent damage due to vibration, and, as far as I know, there is no difficulty arising from this cause which cannot be effectually provided for.

arranged on double-jointed arm brackets. By this means the flame may be brought to the point of the machine to be examined, and a local illumination of anything up to 7 foot-candles obtained. The device works very satisfactorily in practice. It is not necessary that the flame should burn continuously; it is usually extinguished when the machine is working. The double-jointed arm gives a flexibility of movement which permits of high local illumination at any part of the interior of the machine.

TABLE II.—OBSERVATIONS IN VARIOUS MACHINE ROOMS.

Description of Works.	Floor Area sq. ft.	Type of Fixture.		Gas Consumption		Machines in Room.		Total area occupied by machines.	Illumination on Working Surfaces Foot-Candles.		
		No.	Description.	Total c. ft. per hour.	C. ft. per hour per 100 sq. ft.	No.	Description.		Max.	Min.	Aver.
Messrs. Eyre & Spottiswoode	2430	5 4	1 lt. inverted 3 lt. "	60	2·47	2 2 1	Cotterill Miehle Pony	630	6·0	2·2	3·53
Do. Do.	2376	8 4	1 lt. " 3 lt. "	70	2·95	1 2 2 1 1 1	Pony Miehle Huber Perfector Wharfdale Cotterill	1710	8·4	2·6	3·5
Do. Do.	2810	4 5 7	3 lt. " 1 lt. " 1 lt. uprights	88	3·13	3 4 3 1 1	Whitlock Wharfdale Perfector Wharfdale Century		7·0	2·5	3·3
Solicitors' Law Stationery Society	1800	22	H.P. inverted	50	2·78		Cropper & Wharfdale		7·1	4·8	5·8
Do. Do.	2880	27	Do. Do.	61	2·12		Ruling and Stamping		obsc 10·5 clear 16·0	ured 4·3 globe 9·0	globe 7·1 14·0
Cassell's	—	—	Do. Do.	—	—	12	Linotype		on ke 5·3 on M 4·5	y boa 4·4 SS. p 4·5	rd 4·8 late 4·5
Do.	—	—	Do. Do.	—	—		Various		4·0	2·8	3·4

Fig. 10 is a particularly good specimen, but in that case the arrangement of the machines simplifies matters somewhat, a condition that does not always exist.

A feature in the lighting of large printing machines is the provision of special units for facilitating the inspection and repair of the hidden parts of the machine—*i.e.*, the parts that receive no light from the general illumination.

This can be easily and satisfactorily provided for by flat-flame burners

It is often necessary to inspect the type, which is contained in a frame inside the machine, and the flat flame burner answers very well for this purpose.

It gives sufficient light, will stand rough usage, and cannot very well go wrong.

Another device is to have a flat-flame burner arranged on a pillar, to which gas is led through a flexible tube.

Various other machine rooms were visited.

Figs. 2A and 2B show the distribution of light over the working surfaces of the two ruling machines illustrated in Fig. 13. The machines were contained in a basement room having an area of 1,800 sq. ft. The poor daylight illumination is evident from the diagrams.

Fig. 14 shows a fairly large installation of Linotype machines. Their arrangement is very regular, and thus permits of an ordered system of illumination—a condition of things that is, unfortunately, not always possible.

Each machine is separately provided for, so that the lighting is always proportional to the output—an important matter from an economical point of view.

FIG. 14.—Showing Illumination of Linotype Machines.

It is interesting to compare Figs. 2A and 2B, because they relate to the same kind of machine lighted by the same kind of unit, except that in one case a clear globe was used, and in the other an obscured one.

The units at the front of the machines are arranged a little in the rear and

towards the left-hand side of the operator, and 7 ft. above the floor.

The resultant illumination seems adequate in amount and satisfactory in character. (See 'Summary of Machine Shops.')

As will be seen in Fig. 14, there are twelve machines, arranged in two rows

Litho Room.

Some observations made on the stone litho blocks at the works of The Solicitors' Law Stationery Society showed values ranging between 6·2 to 10 foot-candles. Fig. 15 shows such a room.

TABLE III.—OBSERVATIONS IN GENERAL ROOMS—PACKING, FOLDING, AND BINDING.

Description of Works.	Floor Area.	Fitting used.		Gas used.	Gas used.	Illumination on Work Benches. Foot-Candles.			
		No.	Description.	c. feet per hour.	c. ft. p. hour p. 100 sq. ft.	Max.	Min.	Aver'ge	
Solicitors' Law Stationery Society ...	1800	28	H.P. Inverted	63	3·5	6·2	3·0	5·0	
Messrs. Eyre & Spottiswoode*	3550	26	L.P. Upright	84	2·37	2·6	2·4	2·5	On benches
						3·5	2·8	3·1	On table of Cutting Machine
Do. do.	825	14	L.P. Upright	56	6·78	4·8	3·3	4·1	On benches

* The figures given for this room do not represent the efficiency for the whole of the floor area, because a considerable portion was occupied by material and only slightly illuminated.

of six, back-to-back, with a gangway between, so that easy access is gained to every part.

Special units are provided along the gangway to facilitate inspection and repair when necessary.

It is interesting to note in passing that gas is used for melting the type in these machines.

A summary of the results obtained in some of the general rooms is given in Table III.

In conclusion, I would like to acknowledge the kind assistance rendered by those in charge at the various works visited, without which it would have been quite impossible to compile the information in the foregoing all too inadequate contribution to the discussion of this important subject, and also my indebtedness to my assistant, Mr. J. G. Clark, who has prepared for me all the data on which this paper is founded.

Official Notice of Next Meeting.

The next meeting of the Illuminating Engineering Society will take place at 8 o'clock at the House of the Royal Society of Arts (John Street, Adelphi, London, W.C.) on **Tuesday, April 16, 1912,** when papers on the **Lighting of Private Houses by Gas and Electricity** will be read by **Mr. W. H. Y. Webber** and **Mr. W. R. Rawlings** respectively.

Members desiring to take part in the Discussion are requested to send in their names beforehand to the Hon. Secretary, Mr. L. Gaster, 32, Victoria Street, London, S.W.

The Illumination of Printing Works by Electricity.

BY JUSTUS ECK, M.A. (Cantab), M.I.E.E.

[Paper presented at a meeting of the Illuminating Engineering Society, held at the House of the Royal Society of Arts (John Street, Adelphi, London), on Tuesday, March 19th, 1912, at 8 P.M.]

THE object of this paper is to give some indication of the requirements of the industry and to endeavour to find the most economical method of dealing with them.

The work of a printer may be divided into :—

Office work.

Typesetting.

Stereo-casting and electro block-making.

Printing.

Dispatching.

It is not my intention to deal with the office work, as it does not appertain especially to this trade, and, as regards dispatching, I only propose to deal with it casually. The other three divisions form the unique work of the printer.

It has been my good fortune to have had the facility of visiting leading printing works in the vicinity of London, where the following sources of light were in use :—

Arc Lamps, inverted and indirect lighting.*

Glow Lamps, direct and indirect lighting, both carbon and metal filament.

Vapour Lamps, in glass and quartz tubes.

The vacuum tube light has so far not been adopted in this country for printing, but is used, so I am informed, by *Le Journal* in Paris for printing work.

The measurements given in the paper are mostly taken in newspaper printing works, as it was felt that in these places—where the work is chiefly done at night, and where time is the very essence of the business—every effort would be made to secure maximum output of printed matter with the least running cost.

Other important factors have to be considered in this work, such as safety both to the person and against fire, absence of heat and moisture, non-contamination of the air, freedom from glare, ease of supervision of machines and operatives, correctness of colour-discrimination, and absence of eye-strain.

These factors undoubtedly have weight, but it will be clear from the examples given that in many cases other factors have militated against proper consideration being given to them. These other factors seemed to include such things as difficulties with the operatives; unsuitable shape and sizes of the workrooms, due to the high value of sites; and lack of information as to the methods adopted and the results obtained in other printing works.

All the engineers, managers, and other officials I met and conversed with in these various works were most anxious to know what was the best and how it might be obtained, and seemed to consider maximum output of product and safety against fire as the matters of greatest importance.

Inquiry as to data to establish what the increase of output resulting from improved lighting conditions produced generally the reply that, without their present form of lighting, they could not print as rapidly and cheaply as now, and that it was inconceivable to turn to any other

* By an Inverted Lighting Arc Lamp is meant one that distributes its light particularly by single reflection from a surface above the arc, and by an Indirect Lighting Arc Lamp, one that distributes its light partially by double reflection, first from the surface below the arc and then from a surface above, and often (in this case it is called a Semi Indirect Lighting Lamp), by partial transmission through a semi-opaque glass.

illuminant. The reason of this want of positive information is that, contemporaneously with or subsequently to the introduction of electric light, alterations or improvements in the plant have taken place. The sole place where real comparisons were possible was in the hand-composing room, and here increased illumination without glare or perceptible increase in the air temperature had not only resulted in more rapid work, but also in improvement in the eyesight of the compositors.

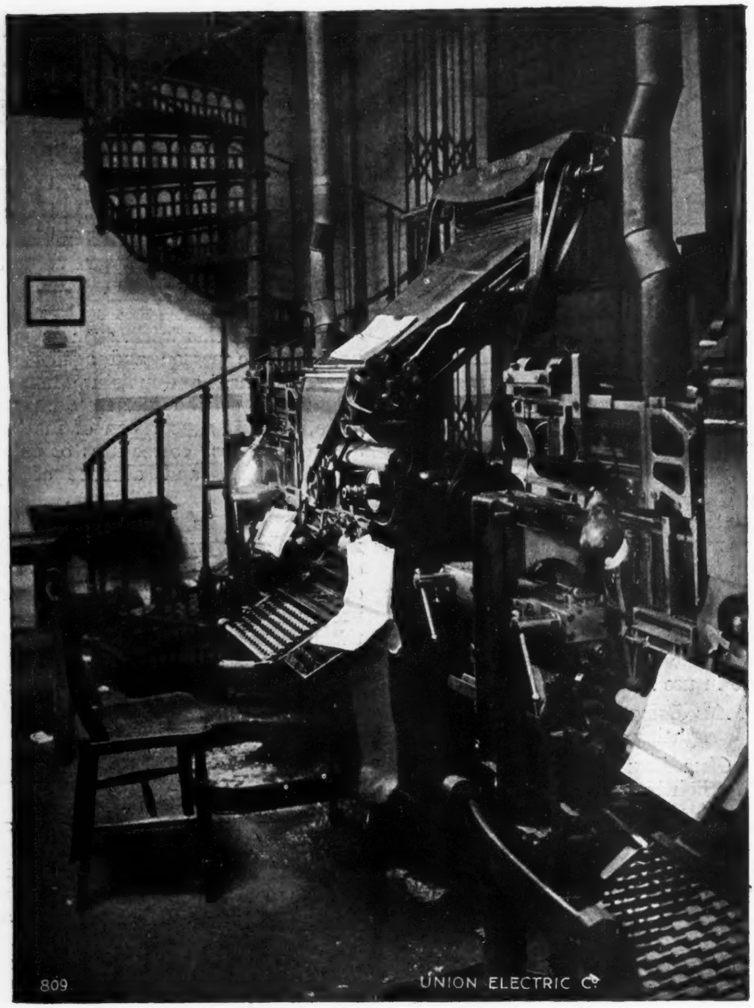


Fig. 1.—Detail Lighting of Linotype Matrix Box.

One important printing firm boldly stated they had not only decreased

their lighting bill this year by over £500, but they had contemporaneously increased their output by nearly 40 per cent.

Such a result should stimulate every owner of printing works to consider his lighting and to endeavour to secure like advantages. I am unwilling to mention the names of places where better and cheaper illumination could be obtained, but they seemed to exist on almost every side.

1. *Typesetting.*—This is done both (*a*) by machine and (*b*) by hand.

(*a*) *Machine Setting.*—Measurements were made of the usual illumination or both Linotype and Monotype machines.

Linotype machines require a good illumination on the copy, less on the keyboard, and a very powerful illumination on the matrices just before they reach the casting-box, for which purpose an (Fig. 1) *adjustable lamp is brought to within a few inches* of the matrix receptacle, a method of lighting which seems to be capable of improvement by means of a suitably designed reflector.

TABLE I.—ILLUMINATION OF LINOTYPE MACHINES.

Illumination.	Matrix Box.	Copy.	Keyboard.
	Ft. candles	Ft. candles	Ft. candles
Maximum	64	15	10·0
Minimum	11	4	2·5
Average*	25	8·3	4·3

* In this connexion it is interesting to note that one compositor was content with, and preferred to have, an illumination not exceeding 4·2 ft.-candles for checking the matrices. This figure has been left out of the table as an abnormal one for practical work.

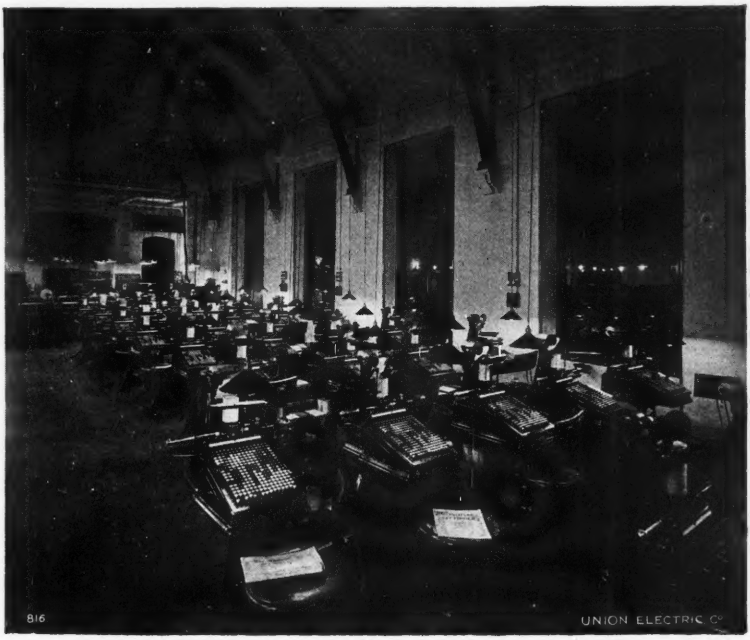


FIG. 2.—Monotype Machines at *The Times* Office Illuminated by Glow Lamps.

Monotype machines would appear to require upon the copy and keyboard the same order of illumination as is apparently usual for these positions on Linotype machines, and it is therefore somewhat surprising to find that a considerably lower illumination is

usually provided. In the case of the Monotype casters, the work is almost

TABLE II.—ILLUMINATION OF MONOTYPE MACHINES.

Illumination.	Copy, right side.	Keyboard.	Instructions, left side.
	Ft. candles.	Ft. candles	Ft. candles
Maximum	6·2	6·2	5·6
Minimum	3·3	2·3	1·7
Average ...	5·4	3·7	4·2

entirely automatic, and the light provided seems sufficient on the working points, although a more liberal general illumination would, prove of advantage.

TABLE III.—ILLUMINATION OF MONOTYPE CASTERS.

Illumination.	Type face.	Reel Face.	Galley Bench.
Average ...	Ft. candles 2·75	Ft. candles 3·9	Ft. candles 6·0

Fig. 2 shows a selection of the Monotype machines inspected, and make clear the methods of illumination usually adopted.

(*b*) *Hand Setting.*—With the skilled compositor the selecting of the type is largely automatic, the operation requiring most light being the reading of partially illegible matter and the checking of the set-up work. The cases of type in use are generally placed—one, more distant, on the slant, and one horizontal, or at a less angle, close to the compositor; the bench length per man averaged from 5 ft. 6 in. to 6 ft. 1½ in., and, when glow lamps were used, one lamp per man was usually the allowance, although in some few cases two lamps per man were provided, and in one case the lamps were spaced at regular 3-ft. intervals.

FIG. 3.—Composing Room of *Lloyd's Weekly* Illuminated by Inverted Arc Lamps.

The following are typical results. The daylight measurements were made

at 10 A.M. on a February morning when no sunlight was available.

In the composing room many other operations besides typesetting are conducted, such as the assembly of advertisements and miscellaneous matter. This is done on horizontal tables called random benches. Column matter is also read through on other benches, hand-pulls are taken and read, and the finished work is assembled in formes ready for passing to the press or casting room.

When general lighting is adopted, as in the case of arc lamps and vapour lamps, the specific consumption of electricity per man or per definite place is difficult to state. I propose, therefore, next to tabulate the measured lighting required by the other operations in the composing room, and then to ascertain the efficiency of the various forms of lighting adopted, on the basis of energy, illumination, and area.

TABLE IV.—ILLUMINATION OF TYPE CASES IN COMPOSING ROOMS.

Light Source.		Inverted Arc Lamps.	Mercury Vapour Lamps.	Glow Lamps.	Daylight.
Slanting Cases	Maximum ft. candles ...	9·4	6·0	18·0	60 (18)*
	Average ft. candles ...	6·8	4·7	7·4	34 (5·6)
	Minimum ft. candles ...	4·4	4·0	2·0	16 (2·0)
Horizontal Cases	Maximum ft. candles ...	14·6	9·2	13·0	76 (8·0)
	Average ft. candles ...	10·5	7·3	5·3	60 (6·1)
	Minimum ft. candles. ...	6·6	5·4	2·2	36 (2·0)

* The figures in brackets are the measurements of artificial light from glow lamps in the same works as the daylight measurements were made.

Figs. 3 and 4 are from untouched photographs of some of the composing rooms mentioned, and show the lighting effects. In each case the artificial

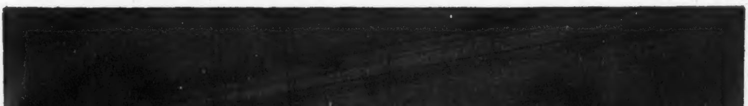


FIG. 4.—Composing Room of *The Times* Illuminated by Glow Lamps.

illuminant has been solely used in producing the negative.

TABLE V.—ILLUMINATION OF COMPOSING ROOMS.

Light Source.		Inverted Arc Lamps.	Mercury Vapour Lamps.	Glow Lamps.	Daylight.
Random benches 3' 2" high	Maximum ft. candles ...	9·4	9·2	17·0	76 (8·0)*
	Average ft. candles ...	6·8	7·2	7·2	60 (6·1)
	Minimum ft. candles ...	4·4	5·4	2·0	36 (2·0)
Imposition benches 3' 2" high	Maximum ft. candles ...	14·2	11·0	14·0	76 (8·0)
	Average ft. candles ...	10·3	6·6	6·3	60 (6·1)
	Minimum ft. candles ...	6·1	1·1†	2·0	36 (2·0)

* The figures in brackets are the measurements of artificial light from glow lamps in the same works as the daylight measurements were made.

† In this place a glow lamp was used to bring the working illumination up to 4·6 ft. candles, but the consumption of this lamp is not included in the energy consumption of the composing room in question.

For the purpose of comparing the efficiency of illumination over an area, the number of watts per foot-candle measured at a standard height on a horizontal surface per square foot has been taken; this serves admirably for calculations for general illumination. The unit of one foot-candle per square foot has been adopted in the United States of America, and there called a lumen.

TABLE VI.—ILLUMINATION OF COMPOSING ROOMS. EFFICIENCY OF VARIOUS FORMS OF LIGHTING.

Light Source.	Inverted Arc Lamps.	Mercury Vapour Lamps.	Glow Lamps.	Daylight.
Area of room, sq. ft.	1984	1727	4276	1980
Height of room, ft.	14·75	12·5	12	10·7 (5·0)
Height of light source, ft.	11	10	5	5
No. of lamps	8	18	177	Top and Side Windows (60)
Mean illumination, ft. candles, bench height	9·3	6·45	3·7	47·0 (5·9)
Energy consumption, watts... ...	4400	3465	5520	— (4400)
Efficiency watts per foot-candle per sq. ft.	·24	·3	·35	— (·376)

FIG. 5.—Stereo Foundry of *Westminster Gazette* and *Daily Chronicle* Illuminated by Inverted Arc Lamps.

I have not ventured to use this designation, in spite of the tempting abbreviation. If the efficiency figure of a system of lighting is known, it is only necessary to multiply this by the area in square feet and the average number of foot-candles required, to obtain as a product the watt consumption. Slight corrections are necessary if the candle-power of the sources of light varies from that taken as the standard for consumption, but these do not affect the value of the result for preliminary or general work.

This would mean on the basis of table VI. :—

5 Arc Lamps of about same consumption per lamp, and therefore no correction is required.	142 Tungsten Lamps. As the original units were rather small and the lighting would be improved by larger units with possibly higher efficiency, a reduction in the ratio of 115 to 100 may fairly be taken, and we arrive at the figure of 3850 watts.

To arrive at the actual cost per hour, these figures must be multiplied by the cost per watt hour, to which must be added in both cases the depreciation and repair cost per hour,

FIG. 6.—Stereo Foundry of *The Times* Illuminated by Glow Lamps.

Take as an example the rooms in the first and third columns of Table VI., and assume another room of, say, 1,800 sq. ft. is to be illuminated with a mean illumination of 7 foot-candles. We then get as first approximations :—

For. (*a*) Inverted Arc Lamps. $\cdot 24 \times 7 \times 1800 = 3024$ watts,	(*b*) Tungsten Lamps. $\cdot 35 \times 1800 \times 7 = 4410$ watts.

together with in the case of arc lamps the cost of carbons and trimming, or in the case of metal filament lamps the cost of renewals and cleaning. These figures cannot be stated except for individual cases, but they may be taken to be in proportion to the watt consumption in either system.

In some composing rooms using metal filament lamps improvements

were in hand in the direction of using Holophane or prismatic directive glass shades; but difficulty was being encountered on the one hand from prejudice, and on the other from the desire to have the light source as close to the object as possible; while in another special case the reflection from the glazed brick surfaces of the transmitted light through the prisms was objected to. Where glow lamps were in use metal filament lamps were adopted for composing, except in the case of the Monotype casters, as the vibration there called for the more stable carbon filament lamp.

Actual measurements of the improvements effected by the prismatic glass reflectors were made:—

1. Make-up table. Ft. candles.	Ordinary Shade.	Holophane.
	4·8	8·0

These measurements are the mean result obtained upon the same table with the same lamps fixed at the same heights.

2. Random Table	Lamp 1	between lamps	Lamp 2	between lamps	Lamp 3
(a) Ordinary Shade	17	3·4	11	4	13
(b) Holophane	7·0	6·0	7·0	6·0	7·0

In case (*a*) there were three lamps in the row, while in case (*b*) there were only two lamps, so that, with a far more even and quite sufficient illumination, slightly more than half the number of lamps in a long row would be required; in this case there was an actual saving of 33⅓ per cent in the energy consumption.

3. Examining Tables	Ordinary Shade	Holophane
Max. ft. candles.	8·0	9·2
Average ,,	5·2	8·0
Minimum ,,	2·1	6·8

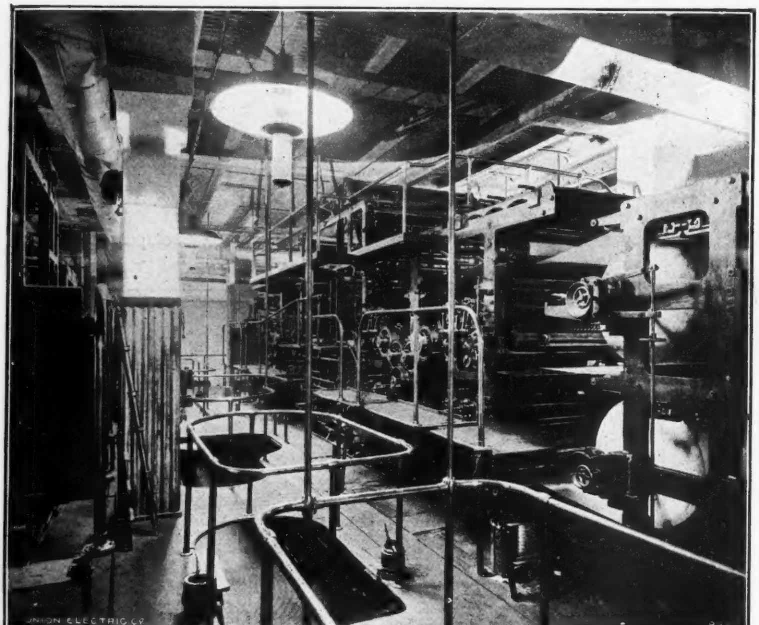


FIG. 7.—Gigantic Rotary Presses of the United New. papers, Ltd., Illuminated by Inverted Arc Lamps.

In this case the energy consumption was the same, but the mean illumination was raised by the prismatic shades to the maximum before obtained, whilst the minimum was improved over threefold. Similar improvements were in another case obtained by the employment of the Benjamin steel reflectors, a typical instance being the increased illumination upon a picking saddle which was raised from 3·2 foot-candles to 5·8 foot-candles, the same lamp at the same height being used in each case. These three cases illustrate most clearly the advantages of the study of practical illumination; three improvements are shown by the adoption of a simple device.

(1) Improved light at same cost.

(2) More regular light at lessened cost.

(3) Increased light at same cost.

2. *Stereo-casting and Electro Block-making.*

It is difficult to obtain much general information as to the requirements of these operations, due to the isolated nature of the work, which is taken advantage of in London to conduct it in small rooms or odd corners.

The plate foundry is most important, due to the inevitable danger of the presence of large quantities of molten metal and the great speed at which the casting has to be done.

The following comparative measurements were obtained :—

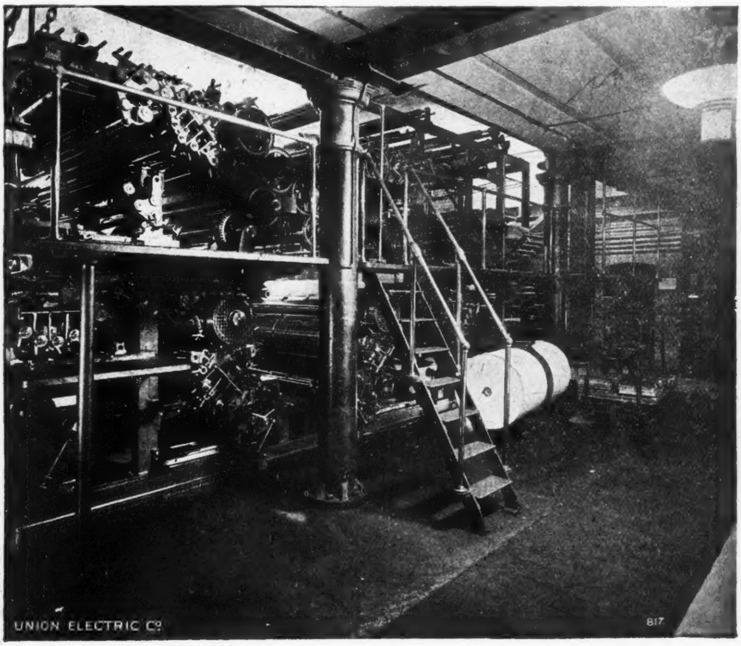


FIG. 8.—Rotary Press at *Daily Graphic* Works Illuminated by Semi-Indirect Arc Lamps.

TABLE VII.—ILLUMINATION OF STEREO FOUNDRY.

Light Source.	Inverted Arc Lamps.	Glow Lamps.
Casting Boxes	14·6	·48
Saddles	14·6	7·5
Floor	4·4	1·2

In the foundry in question, as shown in Fig. 5, an area of 1,512 ft. of a height of 15 ft. is dealt with ; the watt consumption is 2,200, the average illumination on the floor level is 4·4 foot-candles, and the watts per foot-candle per square foot are ·31. This stereo foundry is believed to be the quickest hand-working foundry in the United Kingdom, and probably in the whole world. Fig. 6 shows a somewhat similar foundry lighted by incandescent lamps.

TABLE VIII.—ILLUMINATION FOR VARIOUS OPERATIONS IN PRINTING WORKS.

Appliance	Foot-Candles	Requirements
Matrix Mangle	3·5	General Illumination
Hot Press	3·7	General Illumination
Finishing Saddle	6·7	On Working Face
Picking Saddle	9·2	On Working Face
Engravers' Bench	13·0	On Working Area
Plates	3·0	For all operations
Casters	4·0	For Examining Plates
Pin Searching	3·0	On Working Area
Routers	11·5	On Working Area
Check Saw	14·0	For all operations
Jig Saw	3·6	On Working Area
Imposing Bench	3·2	On Working Area
Moulding Press	9·0	On Working Area
Waxing Bench	23·0	On Working Area

Table VIII. shows the average illumination used in other operations.

3. *Printing.*

A general survey of this section of the work makes it clear that for high-speed rotary presses powerful lamps giving good diffused general illumination are preferred, aided in the interior of the press by additional lighting, usually obtained from one or two carbon filament lamps. The general illumination of the press room must be good and as free from deep shadows as possible, as not only heavy stereo-plates are placed in position and adjusted, but also large volumes of paper have to be received and dispatched without risk or delay.

Figs. 7-12 are again from untouched negatives, obtained by the aid solely of the artificial light sources.

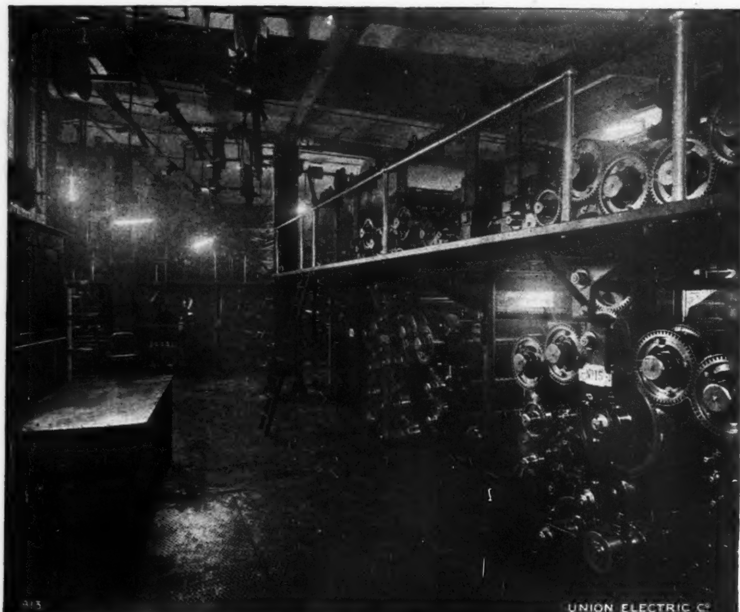


FIG. 9.—Rotary Presses of the *News of the World* Illuminated by Mercury Vapour Lamps.

Unfortunately, it is impossible to give the energy consumed for lighting the above in an entirely fair manner, as in some cases the machine rooms were fully lit and only partially equipped; in others there was an unusually large space for paper reels and delivery purposes; while in others the slow speed of the presses and a liberal application of portable lamps gave results not comparable with the rest. It may, however, be taken that not less than $2\frac{1}{2}$ foot-candles anywhere is satisfactory for a high-speed rotary press.

The large rotary, when of two or more decks, is exceedingly difficult to light, and the most satisfactory results seem to be obtained with indirect lighting coupled with a few supplementary lamps tucked well into the machine in such places where they will

TABLE IX.—PRESS ROOM ILLUMINATION.

Light Source.	Arc Lamps.		Mercury Vapour.	Quartz Lamps.	Glow Lamps.
	Inverted. Fig. 7.	Indirect. Fig 8.	Fig. 9.	Fig. 10.	Fig. 11.
Floor level maximum f.-c.	5·3	6·2	4·0	·72	1·2
Do. average	3·3	2·9	2·24	·41	·544
Do. minimum	1·2	1·3	·62	·05	·092
First deck—Maximum ...	16·8	9·2	4·8	3·8	2·4
" Average ...	6·6	2·9	2·13	1·8	1·1
" Minimum ...	2·6	1·1	·7	·64	·72
Area of room, sq. ft. ...	5662	1880	3388	4800	5416
Height of room, ft. ...	20·5	14·5	14·0	35	20
Height of light source, ft.	16·5	12·0	9·0	33	8
Number of lamps	16	4	24·0	3	63
Energy consumption, watts	8800	2100	4200	2250	1980
Efficiency watts per f.-c. per sq. ft. on floor level	·454	·379	·55	1·17	·67

TABLE X.—PRINTING PRESS ILLUMINATION.

Newspaper.	The Times.	Lloyd's Weekly News.	The Morning Post.	The Daily Graphic.	News of the World.	The Illustrated London News.	The Daily Chronicle.
Principal sourceof light	Quartz mercury vapour	Arc lamps inverted	Glow-lamps	Arc-lamps indirect	Mercury vapour low pressure	Glow-lamps	Glow-lamps
Subsidiary source of light	Glow-lamps	Glow-lamps	Glow-lamps	Glow-lamps	Glow-lamps	Glow-lamps	Glow-lamps
Make of press	Goss & Hoe	Hoe	Hoe	Hoe	Goss & Hoe	Cotterill	Hoe
Electric drive by	Kohler	Ward Leonard	Kohler & Holmes	Kohler	Holmes	Kohler	Holmes
Plate cylinder	2·0	1·6	3·0	·63	7·7	2·8	2 3
Top of press							
Horizontal	2·0	5·4	2·3	1·13	2·4	2·6	·8
Vertical	·04	3·6	2·0	2·2	1·8	1·9	2·1
First deck							
Horizontal	1·8	6·6	1·1	2·9	2·13	—	6·0
Vertical	·03	4·9	·8	2·8	2·0	—	2·3
Upper folder	·09	—	1·2	1·5	—	1·8	1·2
Lower folder	1·0	1·62	1·2	1·5	1·8	—	1·1
Ground level							
Horizontal	·5	4·5	·544	2·6	2·24	·86	2·8
Vertical	·03	2·23	·4	1·3	1·3	·42	2·0
Examiners' table	4·1	2·5	1·1	3·2	6·1	5·9	2·8
Switchboard Vertical	3·8	·86	·75	2·2	1·8	—	—

Light measurements all in foot-candles.

not meet with damage. It must be remembered that the fire risk is considerable, and therefore for this purpose electric lamps seem alone feasible.

With high speed Printing Machines, a considerable quantity of the ink often becomes dissipated in the surrounding air, and falls as an intense black deposit upon lamp shades and globes, thus pointing to the special advantage of Inverted Arc Lamps and Glow Lamps shaded by metal shades for this class of room.

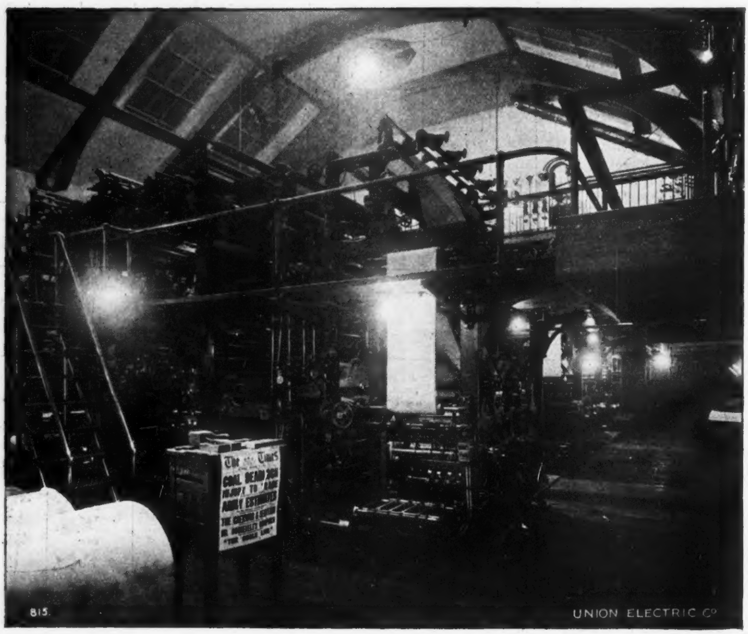


FIG. 10.—Rotary Presses of *The Times* Illuminated by (Quartz) Vapour Lamps.

Flat-bed presses are quite simple to light, and require an average illumination of about 5 foot-candles on the working plane.

Presses for two- and three-colour work need not only a good illumination of not less than 5 foot-candles, but attention must be paid to the spectrum of the light resulting from the source used in order to obtain the best results. In this connexion it was interesting to see one leading journal using in a low press room the combined light of an inverted mantle gas lamp and a tungsten lamp to secure what the printer called "a tolerable makeshift for arc lamp light." In the majority of cases colours could not be matched for either tint or depth of colour (quantity of ink on the paper) by the artificial light used, with the result that if a colour ran out after dusk the machine had to stand until the next morning. Figs. 13 and 14 show a bad and a good example of the illumination of colour-printing machines. In the one case the building is beautifully light and airy, the daylight is excellent, and only the artificial light is at fault. In the other the actual building is not nearly as modern, the daylight is not so good, but the artificial lighting is, even from the point of view of the proprietors, who are exceedingly critical, all that could be desired—ample in

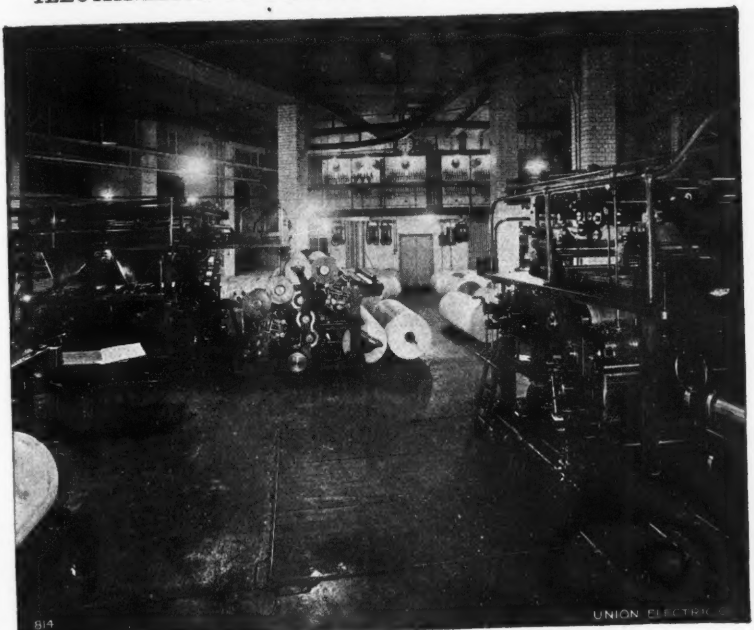


FIG. 11.—Rotary Presses of *The Morning Post* Illuminated by Glow Lamps.

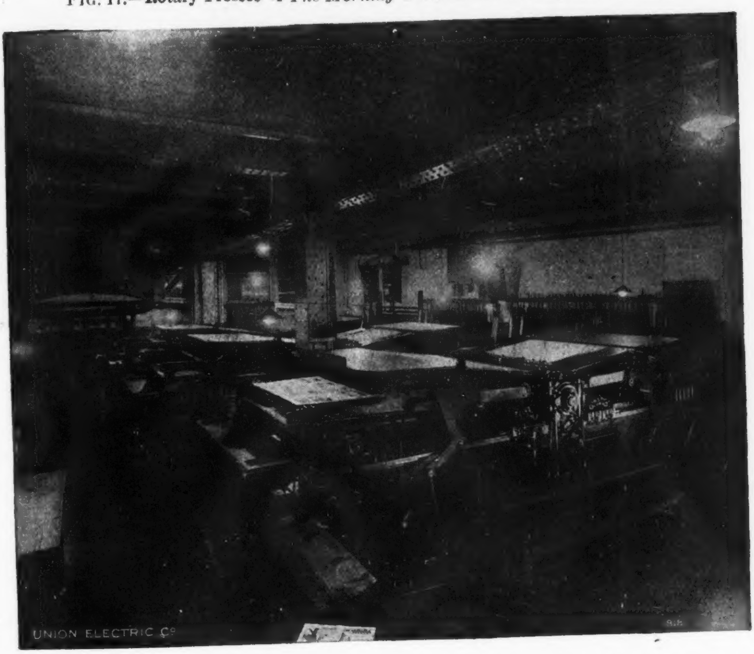


FIG. 12.—Flat-bed Presses at *The Illustrated London News* Illuminated by Glow Lamps.

quantity, agreeable in character, and sufficiently colour-true to permit of inks being matched perfectly and new jobs started by night as well as by day.

4. *Dispatching.*

For newspapers enjoying a large circulation equally good facilities in the way of illumination are required for the dispatching room. The dispatching room of *Lloyd's Weekly* with its gigantic circulation, and *The Westminster Gazette*, with its many daily editions, was measured, with the following results :—

Area	3,065 sq. ft.
Height	10 ft. 6 in.
Height of Light Source	9 ft.
Number of Lamps	10
Kind of Lamp	Cooper-Hewitt
Maximum Illumination on Floor ..	3·2 ft. candles
Average " " ..	2·1 "
Minimum " " ..	1·4 "
Energy consumption in watts ..	1925
Efficiency watts per ft. candle per sq. ft.	.3

These figures, like the others in the Tables, are representative of the illumination under working conditions, with the materials and the people in their usual places. In this room was also a guillotine lighted by two supplementary glow lamps, the consumption of which is not reckoned in the above figures, these produce an extra illumination on the working face of the guillotine of 5·2 foot-candles.

The mercury vapour lamps used are of the uncorrected pattern, giving the usual colour distinction, which, for ordinary single-colour printing, is no disadvantage, and may be an advantage, as the makers claim that slight variations of colour and quality in ink are more easily observed with monochromatic than other light.

The lifts which deliver the printed papers from the press room below are of interest, and had at their delivery points just half the direct

FIG. 14.—Three-Colour Presses Illuminated by Inverted Arc Lamps.

FIG. 15.—Newspaper Office Reference Library Illuminated by Glow Lamps.

FIG. 13.—Three-Colour Presses Illuminated by Glow Lamps.

illumination when the men were in place that they had at other times. The delivery counter, 3 ft. 6 in. high, was remarkably evenly lit with about 2·2 foot-candles.

I have mentioned a good many figures, given some illustrations of places illuminated by different systems, made some suggestions as to slight improvements, and the members of this Society may now well ask me to express some opinion as to the obtaining of the best results. My reply is that in most places I have visited and measured there is room for improvement, which would in some cases take the aspect of a saving of current, and in other cases of rendering the illumination more even and in accordance with the requirements of the average user, thus producing better and greater output in a shorter time. Where the work has to be carried out by night, the strain of direct lighting from either large or small units becomes serious, and, without doubt, the nearer the spectrum of the light resulting from the sources used approaches that of daylight the less fatiguing is the work. Many operatives working with an ample supply of indirect lighting, approximately white, have found their eyesight improve to such an extent as to enable them to discard their spectacles.

Managers of printing houses are realizing the necessity of white walls and ceilings, and are undoubtedly recognizing the importance of such lighting as not only reveals the object, but also protects the operative and assists supervision.

Proprietors of printing works are improving the size, shape, and height of their workrooms, are securing daylight wherever possible, and are seeking for such forms of light as will enable their large investments in machinery to bring the best returns, due to their being regularly run at top speeds.

To each of these classes this Society can give aid and advice.

I desire to express my thanks to the proprietors, engineers, and managers of the various newspapers mentioned for the facilities they placed at my disposal; also the Westinghouse, Cooper-Hewitt Co., and the Brush Co. for details of the mercury vapour lamps; and particularly to Mr. T. E. Ritchie for helping with measurements in my presence, and for photographs taken in my absence.

EDITORS' ROOMS. On Desks.	Max.	Average. Foot-Candles.	Min.
Direct light by Glow lamps with and without shades, screens, or reflectors	6·0	4·4	3·0

PROOF READERS. On Desks.	Max.	Average. Foot-Candles.	Min.
Direct lighting by Glow lamps ... ... Readers' Desk	17·0	9·9	4·8
" " " " " ... ... Assistants' Desk	3·0*	—	·9*

* These measurements refer to the same desk, and it would not be fair to state a mean value, as the maximum illumination is practically always used.

LIBRARY. 12 ft. high. (FIG. 15.)

Diffused lighting. On tables, on Horizontal surface	Average 2·1 ft.-candles.
Direct lighting. Between bookshelves, 31 in. high	" 2·6 "
Efficiency watts per ft.-candle per sq. ft.	·391

ENGINEERS' OFFICE, 8 ft. 3 in. high. On plane 31 in. high.	Max.	Average. Foot-Candles.	Min.
Indirect lighting by Glow lamps	1·8	1·23	·84
Efficiency watts per ft. candle per sq. ft.	—	·442	—

[The discussion of the papers by Mr. Goodenough and Mr. Eck will be published in the next number.—ED.]

DISCUSSION

ON

Shop Lighting.

[Discussion of two papers by Mr. N. W. Prangnell and Mr. A. E. Broadberry on 'Shop Lighting by Electricity' and 'Shop Lighting by Gas' respectively, read at a meeting of the Illuminating Engineering Society at the House of the Royal Society of Arts (London), on Tuesday, Feb. 20th, 1912. See *ante*, pp. 125–151, March, 1912.]

THE CHAIRMAN, after congratulating the authors on their papers, said it was the first time they had had the pleasure of seeing Mr. Broadberry at a meeting of the Society, and he was to be complimented, as a keen fighter for gas, on having kept his fighting propensities so well under control. He agreed with Mr. Prangnell that it was a difficult matter to evolve definite rules to guide them in shop lighting installations, because the factors were so many and varied. That was well exemplified by the instance of the firm with forty shops and nine different methods of dealing with their requirements. This only emphasized the necessity for the study of illumination by all those who had to advise the public upon lighting installations, and in this connexion it was becoming increasingly necessary that officials of gas and electric supply authorities should study the subject, because the public were looking more and more to them for advice. This was why the Society had in it such capabilities for useful work.

Mr. Broadberry had, he took it, given a promise at the end of his paper of further contributions to the transactions of the Society, because he had outlined a number of experiments which should be carried out, and no doubt he would now proceed to carry them out and give the results later on. He agreed with Mr. Prangnell that screened lighting was very desirable for shop windows, and was pleased to see that it was coming more and more into vogue. At one time the system of lighting was such that it almost appeared as if it was glow lamps that were for sale, for the goods could hardly be seen at all for the lights.

MR. HAYDN T. HARRISON congratulated both the authors on the papers they had placed before the Society. He considered that when dealing with shop lighting the example of good stage lighting should be borne in mind. For instance, a stage viewed from the auditorium was very similar to a shop window viewed from the street, and if the latter was well illuminated it would attract the attention of passers-by. But, their attention once attracted, individuals would often wish to inspect the goods more closely, and for that purpose would sometimes glue their noses to the window glass whereas the shopkeepers naturally wished them to go inside to inspect and be told the merits of the goods. Thus, in better class shops, it will be noted that the displays in the windows are generally laid out so as to advertise to the multitude and not to the individual shop-window gazer.

To get this general effect outside lighting was sometimes advisable, especially when the window setting was of little depth; but he was glad to note that Mr. Prangnell had dealt with shop window lighting almost entirely from inside, because he had got an illuminant that he could use inside, which was generally preferable. Mr. Broadberry, on the other hand, dealt with it from outside because, with high pressure gas, he had got an illuminant which could only be used outside.

The question of the colour of the light should be decided by the class of goods exhibited, and not by an attempt to imitate daylight. There were many articles which appeared more attractive by artificial light, containing as it did a higher percentage of yellow and red rays than by daylight. For example, he

remembered when the City Meat Markets were first lighted by flame arc lamps there was a great outcry because the meat did not look fresh. In this case the materials used in the manufacture of the carbons were modified after careful experiment, and now the butchers were satisfied because the meat looked fresher by artificial light than it did by daylight. Therefore, when he was consulted concerning shop lighting he was careful to provide a light of such a spectrum as to improve the appearance of the goods to be advertised.

He was surprised to note from Mr. Broadberry's figures the enormous variation in the degree of illumination of some of the gas lighted windows; from 80 foot-candles at the top to 5 foot-candles at the bottom of a window certainly was not even illumination. In daylight the same diversity might occur, but the lower part of the window would be the better illuminated. Therefore, this complete and extensive reversal had rather the appearance of topsyturvydom. In order to avoid this, the use of inside lamps in the form of batten and footlights, as used on the stage, was often an advantage.

He noted that Mr. Prangnell stated that the night photograph of the Kodak Co.'s window does not do justice to the illumination, because the street lamps cast shadows. He thought that Mr. Prangnell should be thankful for a little shadow which relieved the flatness of an otherwise shadowless illumination.

Mr. R. J. Wallis-Jones referred to the ever-increasing demand for a higher standard of illumination, especially in shop lighting, and said that in some of the large establishments in London the interior lighting by means of inverted arc lamps, although well diffused, produced on him a sombre effect. This method of lighting also produced dark shadows or patches on the ceiling. He thought that those interesting themselves in new forms of glass diffusers might consider whether they could not design some type of top shade which would do away with these objectionable dark patches. He agreed with Mr. Harrison on the question of shop window lighting (with windows dressed back) that the best effects were produced when theatre stage lighting was copied. With regard to Messrs. Seifridge's installation, which was carried out under his supervision, he showed a drawing of the special form of trough reflector lined with mirrors which had been used. This is suspended inside from the transome bar by chains, so that the angle could be adjusted to get the best effect. The lamps are arranged horizontally in the reflector, and cannot be seen at all from the street, and although the lighting was from the top only, very even distribution of light and good illumination were obtained. When visiting Berlin in 1908 he noted in many of the large establishments there a system of lighting similar to that shown by Mr. Prangnell (Fig. 5). Arc lamps were suspended in the centre of the space above the windows, having below them ground glass or glass of prismatic type. The lighting effect was good, but the arrangement had the objection from his point of view that any one looking into the window from the street could see the source of light. In some cases even yellow flame arc lamps were used in this way. With regard to outside shop lighting he had never been able to understand why shopkeepers seemed to rejoice in hanging outside their shop windows so many big arc lamps at a low height, the result being that would-be purchasers were unable properly to appreciate the wares on account of the intense glare. Referring to Mr. Broadberry's paper, the feature that struck him was the very high degree of illumination which had been obtained in most of the instances quoted, in some cases going as high as 80 foot-candles. In a table published a short time ago in *The Illuminating Engineer* it was stated that 4 foot-candles is a good average for shop lighting.

It gave him much pleasure to acknowledge the friendly co-operation of the gas engineers and the valuable contributions that they had given to the

Proceedings of the Illuminating Engineering Society. He mentioned that it would be interesting if some observations were taken in some large shops, firstly when empty of people, and secondly with a large number of people present. The apparent effect on the lighting was that it was greatly reduced when the shop was full of people.

Mr. H. W. Woodall said he was not prepared to speak, but had enjoyed immensely listening to the discussion. He had started as an electrical engineer, and saw some of the early troubles of electrical engineering. He had then reverted to gas, and it afforded him the greatest pleasure to see gas and electrical engineers sitting together amicably, because from reading the technical papers one was rather apt to gather the impression that they were not quite the friends they ought to be.

Mr. R. G. Shadbolt said the factor which impressed him most in this question of illumination was the personal equation. It was sometimes astonishing to find the amount of light some people could stand. He remembered an eminent mechanical engineer who said he could never get a satisfactory light until the metal filament lamp came out, because he could then have close to his eyes a light of from 60 to 100 c.-p. At first he thought it was a joke, but it was perfectly correct. This man had exceedingly small pupils, which could stand an immense amount of light compared with other people.

Another factor was that if they increased the amount of light in a street by two, three, four, or five times, they upset the equilibrium of that street or district, and it took some time to bring it back again, because if they increased the outdoor lighting they had of necessity to increase the indoor lighting to an almost corresponding extent.

This brought him to the point that from the aspect of benefit to the eye and from the hygienic point of view generally, when should we realize that we had reached a maximum—because there was maximum, and he was bound to think that sometimes we overreached it. In experiments on high power lamps he had found that after a certain light intensity one appeared to be insensible to any increase. It might be doubled, but it was not noticeable, and it was only when it was reduced that the comparison came up again, and one realized that one had been exposed to a very powerful light. The question of balance was, to his mind, an important one, and he presumed that the shopkeeper put a great glare in front of his shop not so much to display his goods as to attract the passer-by.

Mr. F. W. Willcox said it was a hopeful sign to find a central station engineer like Mr. Prangnell taking an interest in illuminating engineering and studying to improve the lighting installations of the consumers on his circuits. It would be a great gain for better lighting if engineers of other lighting companies and supply authorities would do likewise.

In the United States it had been found to be a desirable practice for supply authorities to employ an illuminating engineer to look after the lighting requirements of their customers, just as a power engineer was employed to follow motor and power development. This was a practice which deserved to be extended to every lighting station.

Referring to Mr. Shadbolt's remarks, he said that it was well known that the eye gained very little from an increase in illumination beyond a certain limit, say 4 or 5 foot-candles, *provided the lighting be uniform.* When the lighting was not uniform there resulted a desire for great intensity and excessive brilliancy of individual lights. Compared with illumination as seen in Germany and France, and even in South America, the shop lighting in the cities of England was very much in need of improvement. The examples which had been shown that evening were oases taken from a desert of bad lighting installations. The trouble seemed to be that with the introduction

of the new high efficiency metal lamps the consumer had tended too largely to continue his old lighting equipment of worthless shades and fittings. It was like putting new wine into old bottles. With gas the consumer had to deal with an illuminant, such as the inverted mantle, which required practically a complete new equipment of shade and fitting, and thus new gas lamps gave better illuminating results than the average installation of new electric lamps.

While it was not possible to lay down general rules for the lighting of all kinds of shops, it was possible to establish a few guiding principles of good lighting, which, if applied more generally, would correct the numerous installations of exceedingly bad lighting which form to-day a serious obstacle to the more effective use of gas and electricity for illumination work.

The first rule of good lighting requires that the lamps be placed at a proper height. There are innumerable cases throughout the country where lamps are hung entirely too low. This hanging lamps too low is a general fault, and is a direct cause of glare and uncomfortable lighting. A much greater illuminating efficiency would result if lamps were hung at a proper height. With lamps located well up and equipped with scientific reflectors, the light could be uniformly distributed, and much better illumination obtained without the excessive glare and unpleasant brilliancy found in the majority of cases. It was no longer necessary to hang lamps directly in the line of vision at the table or work, because the light could be effectively reflected and distributed upon the working plane from lamps located well up overhead.

With regard to window lighting, Mr. Harrison's comparison with the lighting of a stage was well chosen, provided one had the same conditions as on a stage, viz., some depth. Most English shop windows were, however, far too shallow. At present there was hardly an alternative to lighting such windows from the front and on the outside. In the United States the lighting of windows from the outside was rather the exception than the rule, because the windows were of sufficient size and depth to permit effectively lighting them from the top. With proper window depth it was not necessary to employ reflectors or lamps at the bottom of the window as suggested by Mr. Harrison. The window lighting in Marshall Field's large store in Chicago stood out magnificently at night. A row of lamps with high power reflectors was placed in a concealed position along the inside top of the window, with the result that the window stood out like a stage or picture.

There should be some relief given from the brilliant light of flame arc lamps hung in front of shop windows in London, many of which hang so low that they can be touched with the hand. Such excessive brilliancy and glare were a great menace to good illumination, and spoiled the effects of sign lighting and similar displays.

As an example of the trade-pulling value of good lighting, the speaker mentioned the case of a shopkeeper in the main avenue of Birmingham, Ala., whose rent was raised by his landlord. He threatened to move, but the landlord told him he could not afford to do it as his location in that street was so important. But the merchant moved to a new shop four blocks away, and said he would carry his trade with him. He got all the shopkeepers in his new thoroughfare to subscribe to a fund for a special scheme of illumination in which they hung lamps across the street, and kept them going until 9 P.M. on ordinary nights and 11 o'clock on Saturdays. The result was that this new avenue soon became the first avenue for trade.

Another point had been noticed by the New York Edison Company—that as soon as the street lighting was improved, the shopkeepers tended to increase their lighting.

In Denver (Colorado) a census of the people passing various points in the city had been taken for a number of evenings, and it was found that the number of people passing a given point was in direct proportion to the candle-power at that point.

Another matter to be taken into consideration was the education of the

shopkeepers in the proper dressing of their windows in relation to the lighting scheme.

A second general principle to be observed for good lighting was the proper spacing of lamps; and a third principle was the use of efficient reflectors. To secure good lighting was a simple matter with the present-day designs of such reflectors as Holophane.

In the speaker's opinion, the question of daylight colour value was being overdone. We should aim at giving the most agreeable light for the particular circumstances. The necessity for getting daylight effects was not of such importance as had been made out. If it were very necessary to have an equivalent to daylight for colour matching in certain premises, then a small counter lamp, such as a small box type of Moore tube, giving a daylight spectrum, could be provided at various points, and thus leave the general lighting of the premises to be executed on the basis of the most practical, agreeable, and effective illumination.

THE CHAIRMAN said he could thoroughly recommend members of the Society to become members of the American Illuminating Engineering Society, if only to get their transactions and their magazine each month. He had the pleasure of being a member of that Society, and one got from it a very great deal of useful information, a sample of which they had just had from Mr. Willcox.

MR. A. H. RICHARDSON agreed with the conclusion that it is not yet time to set up standards of methods and measurements; nevertheless, the figures of foot-candles given by the two authors showed such a marked variation—and yet the lighting was said to be good in all cases—that he humbly suggested that the Society would do a good work if it organized a series of tests with different inside and outside fittings, fixed at varying heights and at varying distances from the horizontal surfaces, so as to obtain some sort of data that would be useful to all engaged in illumination problems. The information gathered could be presented in the form of tables and curves, which would be very interesting.

MR. JUSTUS ECK said he would like to enlarge the excellent motto that Mr. Broadberry had adopted, and say "Good trade follows good lighting," especially as he upheld the opinion that lamps should produce a light having a spectroscopic value as near that of the solar spectrum as possible. By good trade, he meant the honest selling of goods on their own intrinsic merit, and not because some particular tint of yellow or red imparted to them a false value. Good trade was the permanent trade established by satisfactory periodical dealings that "will stand daylight."

The information contained in the paper on lighting by gas was most interesting, and showed excellent results, both as measured by the eye and the photometer; but he would like, as an electrical engineer, to ask the author to supplement his interesting paper by some polar curves of the lamps he described and illustrated.

The question of the colour of artificial illuminants had been again raised that evening. Mr. T. E. Ritchie's paper demonstrated to the Society the excellent results obtainable with the more highly developed electric and gas lamps now in use; but one would think from the remarks of some speakers that daylight was a mistake, and better results would be secured for all purposes if the community adopted yellow-tinted window glass, and possibly, for outdoor use, also yellow-tinted eyeglasses, to correct the poor quality of actual daylight produced by the sun, as well as artificial daylight produced by other sources.

He had seen weird arc light effects in the interior parts of some of the shops from which Mr. Prangnell's selected pictures were obtained, but they were produced from enclosed arc-lamps of an American make, giving a superabundance of undesirable violet rays, while the lighting was "direct."

Mr. Prangnell did well to support indirect lighting, as by its means the most desirable forms of illumination had been, and would be, obtained.

The question of shop lighting seemed to come under three heads :—

1. Exterior or pavement lighting, attracting the possible purchaser to the neighbourhood, whether it be a fourth avenue or any other place ;
2. Window lighting, especially if combined with deep windows to show the goods in the most attractive form, and promote desire in the mind of the observer ; and
3. Interior lighting of such a true and agreeable kind as will retain the prospective customer so long on the premises, and render him so satisfied with the quality and value of the goods, as to make him a purchaser of the permanently profitable variety.

He was able to show to the meeting, by the courtesy of Messrs. Frederick Sage & Co., who had European and Colonial, as well as London, experience to aid and guide them, some pictures of the ideal window lighting system, which had been already mentioned by Mr. Wallis-Jones as extensively used.

The drawings showed the method and appearance produced, while the photographs showed actual examples photographed when in use. As the photographers had not that unique ability of taking pictures by artificial light possessed by one or two members of their Society, he was bound to agree with Mr. Prangnell that photography did not always do justice to the facts, and had therefore brought a nearly full-size model of an ideal shop window lighting system. This window, dressed by the well-known outfitters Messrs. Horne Bros., whose many shops presented at all times a valuable example of careful maintenance and absence of those needlessly rusty abominations referred to by Mr. Prangnell, was illuminated by two " Excello " lamps of an individual consumption of 264 watts, or, including line losses, 300 watts. They would notice that none of the mechanism of the lighting devices was observable, that the diffusing glass prevented any glare, and that the goods were illuminated in such a way as to make them both attractive and striking, without colour distortion.

Mr. W. E. Bush (British Thomson-Houston Company) showed and described some slides of shop lighting installations carried out by direct and indirect tungsten units.

Mr. Leon Gaster congratulated the authors on their papers, and remarked on the interesting fact of two contributions by representatives of gas and electricity being read on the same subject and on the same platform. At one time it would certainly have been considered impossible to have an amicable discussion of this kind.

He agreed with Mr. Prangnell's suggestion that the window lighting in different districts would vary according to the class of business. He believed, however, that in the highest class of shops it was becoming customary to imitate the conditions of illumination on the stage, *i.e.*, to have a window brightly illuminated by concealed lights, and not to distract attention from them by bright lights just outside. In the theatre, in the same way, the auditorium was left in subdued light in order to concentrate attention on the stage.

Another point to be noted was the growing recognition that an artistic window should contain a few choice samples of goods, arranged in a striking way, and should not attempt to be an inventory of the contents of the shop. This method was being used by the best firms to an increasing extent, and it greatly facilitated the provision of good illumination ; it was notoriously difficult to light an overcrowded window successfully. This led him to speak of another point—the need of considering the dressing and the lighting of a window together. On the stage it was regarded as quite essential for the design of the scenery and the action of the play to be correlated with the lighting effects, and similar co-operation in shop window lighting would doubtless enable more artistic results to be secured.

Mr. Gaster then proceeded to refer to the " deck lighting " system of window lighting, in which the lamps were boxed off in a separate compartment above the contents of the window,

so that they were concealed from the eye, and could be attended to without disturbing the goods. The rotating window device, whereby one window could be arranged out of sight while another was on show, and all window dressing done behind the scenes, was also coming into use.

Another point that deserved notice was the value of time-switches which automatically turned off the gas or electricity at a predetermined hour at night when the time of traffic was over and the crowds had gone home. By this means the advertising value of a window could be substantially increased.

In conclusion, Mr. Gaster referred to the "Augur" exhibition of shop window lighting in Berlin in 1908.* At this exhibition eighteen model windows, all of exactly the same size, were fitted up and lighted by different firms, the cost of installation being limited to 500 marks in each case. A price for electricity and gas was also assumed, and exhibitors were invited to state, outside their windows, what the running cost of lighting it would be. Perhaps in the future a similar demonstration might be arranged in this country.

MR. J. S. DOW (*communicated*).—A word or two seems called for by Mr. Prangnell's remarks on the difficulty of suggesting a standard for shop lighting. As regards illuminated windows this is doubtless true, much depending on the style of shop and the district. But surely it should be possible, after making the necessary investigations, to frame a rough standard of *minimum* illumination for counter lighting. At present the figures doubtless vary, but yet the values given — 6–15 foot-candles in drapers' shops and 2–8 foot-candles in jewellers'—do not vary so enormously. Similar variations might have been quoted for schools and libraries, and yet in these cases we were able, from theoretical considerations, to deduce a rough standard which was in conformity with practice. Moreover, the mere fact of there being existing variations is hardly evidence against the possibility of establishing a desirable minimum. Probably in some cases it would be found on investigation that the merchant could have managed with a smaller illumination, and in others that the amount of light was not really enough, even although the merchant did not realize it.

* *Illum. Eng.*, Lond., vol. i., 1908, p. 579.

Mr. Prangnell, in referring to the Selfridge installation, raises the question of reflections in the glass. In some cases the reflections of passing vehicles are a distinct inconvenience. I have met cases in which this difficulty was largely mitigated by adopting brighter illumination and employing a lighter background.

Many of the excellent photographs shown by Mr. Broadberry illustrate the use of powerful lamps outside the window, but I cannot help thinking that it would often be preferable to surround them, on the side facing the street, by some form of quaint illuminated device which would moderate their brightness, and probably be equally efficacious in attracting attention.

Time did not permit of my referring in the discussion to a piece of apparatus which I have prepared for lecture purposes for illustrating window lighting. This consists in a small box fitted with rollers carrying suspended small glow lamps which can be raised or lowered, and screened or otherwise, so as to simulate actual conditions in a shop window. The contents of this model window can be easily arranged to represent a drapery, jewellery, or other form of shop, and the lamps are fed by a small portable 4 volt accumulator.

MR. V. H. MACKINNEY (*communicated*).—The question of shadow in window lighting is often an important problem. In some cases it would surely be wrong to aim at entirely "shadowless" conditions. I recall, for example, the case of a window in the Woolwich Arsenal Co-operative Stores, a photograph of which is reproduced in the accompanying figure.

The general illumination in this case is provided by eight concealed 50 watt tungsten lamps in Holophane reflectors, but it was also found desirable to add one 100 watt lamp in a tilted concentrating

reflector at the side so as to superimpose over the main illumination a distinct shadow. The benefit of this will be seen from the appearance of the boy's face, which is shown in strong relief. In such cases a complete absence of shadow is often disliked, because it makes the window appear flat and uninteresting. There is, however, an opportunity for considerable skill in arranging for the shadows to have the requisite depth and softness, and to come from the right direction.

MR. J. G. CLARK (*communicated*).—I would like to make a few remarks in amplification of Mr. Broadberry's paper. Referring first to Figs. 12 and 13 in the paper, I found time to make a few observations of the illumination under the two systems of lighting, with the following result:—

Position in Window.	System. 750 c.p. Outside Lamps.	80 c.p. Inside Burners.
A	9·0	7·6
B	8·4	4·6
C	16·1	4·0
D	16·1	7·6
E	8·0	3·2

FIG. 1.—Lighting of a window in the Woolwich Arsenal Co-operative Stores, showing effect of light and shade (*Mr. V. H. Mackinney*).

The consumption of gas is, of course, different with each system. Whereas the outside lamps consumed 18 cubic feet per hour each (36 cubic feet in all), the inside burners consumed $3\frac{1}{2}$ cubic feet each, or $16\frac{1}{2}$ cubic feet in all. It is difficult, in fact impossible, to com-

pare the value of the two systems scientifically, because so much depends upon the "fancy" of the shopkeeper. The outside system is, of course, more effective in illuminating the footpath, as is shown in the following summary :

	System.	
	Outside Lamps.	Inside Burners.
Illumination along footway.	7·3	2·4
	8·2	2·4
	9·2	2·4
	9·7	2·4
	8.7	2·4

The figures refer to various points along the centre of the footway. I was perfectly visible at every part. This effect is, I think, due to the absence of sharp contrasts of illumination.

Bootshops.—In regard to Mr. Broadberry's remarks on the lighting of bootshops. The difference in window dressing is largely on account of difference in the class of goods sold, but for effective illumination it would seem desirable to have plenty of white background.

Some observations made at Messrs. Lilley & Skinner's shop at Forest

Fig. 2.– Lighting of a provision shop by small gas units (*Mr. J. G. Clark*).

informed that both inside and outside systems are used on very busy occasions, when the illumination would, of course, be the sum of the values given. I think a study of shop window lighting by units concealed at the top leads one to conclude that the mere measurement of illumination is insufficient to describe the "seeing power" of an installation, because where, as in the case of Maynard's (Fig. 3 in paper), the illumination dropped to 1 foot-candle, in places the objects appeared to be

Gate (Fig. 8 in paper) indicated the following values.

The "surface brightness" of the white surfaces in the window was 10 to 12 foot-candles, and the illumination on the vertical surface of the glass midway between the lamps was 49 to 9 foot-candles. The visual effect was good. Many other points might be alluded to in connexion with this many-sided problem, but time does not permit of their full consideration.

Fig. 2 reproduced herewith forms an interesting comparison with Fig. 4 given in the paper. The shops are of the same kind, but small gas units are used in one case and large (3-light) units in the other. The illumination due to each system might be roughly compared as follows :—

	Small Units. Ft.-Candles.	Large Units. Ft.-Candles.
Counters...	10 to 13	5·8 to 4·8
S.B. of Walls ...	9 to 10	5 to 6
On floor	9 to 10	4½ to 5½

Or approximately in the ratio of two to one. The ratio of gas consumption is also about two to one (*i.e.*, 31½ to 56), so that the practical efficiency may be regarded as approximately the same in each case. An interesting feature of modern shop window illumination is the use of appliances which will automatically extinguish the gas at a certain time. These appliances are clock controlled, and they make it possible for a shopkeeper who closes at, say, 7 o'clock to retain the advertising value of his window until a late hour. Such appliances are cheap and reliable, and need no more attention than a weekly wind. Another important aspect of shop lighting is the appearance of the fittings during daylight. It is a point that is often overlooked, but it is easily possible for a lighting unit to be a pleasing part of the shop's decoration, not, as sometimes appears, an inelegant structure.

MR. J. S. PLUMTREE (*communicated*).—I am sorry Mr. Prangnell did not deal at greater length and more detail with the use of arc lamps for exterior, window, and interior shop lighting, for although he mentions favourably Mr. Justus Eck's recent articles in *Electrical Industries*, he does not point out that these are general ones dealing with arc lamps for many industries, and not the special application of them to shop lighting.

One of the problems that is often encountered in shop window lighting is the reflection on the window surface of neighbouring lights, rendering the comfortable observation of the goods displayed difficult. To overcome this difficulty a powerful illumination must be given in the display space behind the window, a matter of importance when deep window display is being made. Powerful metal filament or gas lamps are unsuitable, and would produce either too great a heat or too high a bill for permanent retention. In such cases I have used the Kohinoor or semi-enclosed arc lamp. This has the high efficiency of ·61 watts per m.h.c.p., and burns for fifty hours with a single carbon; and it is also available in moderately small units of a working pressure, enabling three lamps to be on each circuit on the usual supply pressure of 220 to 250 volts. With these lamps an illumination is secured that renders the user independent of his neighbour, while he secures brilliant, and to a very large extent a daylight, illumination.

Where close window dressing has to be considered, the same lamp, fitted with hemispherical reflector, will produce a most satisfactory result and even distribution.

For use in showrooms where the height is restricted, the same lamp, fitted for indirect illumination, brings into view the whole display of stock or models on sale, instead of restricting the field of observation to adjacent articles only.

I regret the time available prevented me showing the Society the lantern-slides I had prepared to illustrate the above comments. I believe that a properly taken untouched photograph is of material assistance in showing to third parties the illumination effects obtained.

MR. J. DARCH (*communicated*).—"Trade follows good lighting" is an enticing motto, but the words "good lighting" have been sadly misinterpreted. Witness the examples, in one of the papers, of four 600 c.-p. lamps to one narrow shop front, and that within 5 ft. of the goods exhibited. Is this good lighting? It is "liberal," but is it good for the eyes, and does it help one to see any better?

Some five or six years ago the City of London introduced a regulation prohibiting these inflictions; it would be well if this Society took steps to agitate for their abolition in every

district of Greater London. They are a menace to traffic, injurious to the eyes and nerves, and, if the poor misguided shopkeepers did but know, they detract from the goods they are supposed to exhibit. In the examples referred to there is no attempt at diffusion—that most important of all features in good lighting; and very hard lighting may be noted in Fig. 5,* together with an unevenness, dense shadows, and the obstructiveness of the lights themselves. The gas companies, who now supply not only gas, but fittings and fitters, should consider that their best interests lie in *good* lighting rather than in redundance. They may thereby sell a little less gas just at present, but their future will be the better secured.

The shopkeeper wants light to attract the human moth. Light is unquestionably an attraction, but that attraction does not lie in its source, but in its illuminated surfaces. It is for us, therefore, to make it clear to the shopkeeper that if the blaze of light he so much desires comes, not from the lamps, but from his goods, the public will be able to bask in a flood of light that is not only far more agreeable, but that will bring with it impressions of tempting articles for sale. Just as a theatre stage is a beautiful picture that itself lights up the auditorium, so should shirt fronts, silver teapots, and stationery cast a pleasing glow of light over the footway, and, more important, into the wondering eyes of the arrested pedestrian.

Further, assuming that the shopkeeper has no other motive than to make or save money, it is the function of the illuminating engineer to point out that the illuminating effect of lamps in the field of vision is not commensurate with the amount of light shed abroad, but with that received into the eye. Such lamps simply contract the pupil, and thereby shut out and waste in the desert air the very light he vainly thinks is making an impression.

In shops, as in most other lighting, the main thing is to render the exhibits clearly and easily visible. To do this it is necessary:—

(1) To keep all lights absolutely out of the field of vision.

(2) To provide reasonably even general lighting, either by indirect or by effectively shaded direct lighting.

(3) To provide local lighting where necessary for special display, inspection of detail, desks, &c.

(4) To provide for an intensity of illumination suitable to the colour of the goods and surroundings. A bright light is, however, generally necessary. This would be 3 to 6 foot-candles in light surroundings, and 6 to 10, or more, in dark. The 20 to 30 foot-candles referred to in the gas paper is entirely unnecessary.

(5) Economy will be effected by having every surface as light as possible.

The nature of a business and the mode of dressing a shop window will naturally govern its lighting. Excepting in those cases where the goods are dressed close to the window, most shop windows may be sufficiently lighted from above only, providing every means is adopted to facilitate diffusion. It must be remembered, however, that a shop front, unlike an enclosed room, loses its light through the glass, with a considerable diminution of intensity as it goes downwards; hence, with top lighting only, some windows need foot lighting in order to obtain uniformity, others batten or central lighting. Batten lighting was referred to unfavourably in the discussion, and in most cases it is unnecessary; but, where desirable, I can conceive no more effective means of illuminating otherwise difficult points.

I would like to express my appreciation of Mr. Prangnell's paper, which was filled with excellent matter. I would suggest, however, that Adnil's indirect lighting fitting would be better without the upper reflector, as "sanding" will not prevent a concentrated reflection of the lamps below.

Mr. Broadberry deserves the thanks of the members for the care bestowed upon his paper, and I consider his shop fronts (Figs. 3 and 8) well lit. My adverse remarks upon some of the

* *Illum. Eng.*, March, 1912, p. 143.

points in his paper are directed, not in any way against the use of gas, but the mode of handling it.

Mr. N. W. Prangnell (*in reply*).—In commencing my reply to the discussion on this very important subject, I should like, firstly, to congratulate Mr. Broadberry on his excellent paper and photos, and secondly to let the Society know how extremely pleasant the negotiations between Mr. Broadberry and myself were in carrying out the preliminary arrangements for our joint papers. I sincerely trust that this may be the foundation of many more joint papers by those of us interested in rival forms of illuminants.

The chief criticism I have to make of the bulk of the illustrations of gas lighting given us by Mr. Broadberry is that the illuminants are so very much exposed, though he is able to show us in his illustrations (Nos. 3, 7, 8, and 10) that it is quite possible to screen his lamps in a very practical way.

I notice by the general remarks of the several speakers that it is practically agreed that the time has not yet arrived when it is possible to evolve definite standards for shop lighting installations. Mr. Dow, however, thinks that a standard should be possible with regard to counter lighting. If any standard is possible, I am rather inclined to think that this is the only one.

I am glad to see that Mr. Harrison and Mr. Wallis-Jones agree that the method of window lighting mostly to be sought after is that which is somewhat on the lines of stage lighting, though in this comparison, I think, they only refer to batten lighting. In stage lighting there are also employed powerful lamps which can be focussed on to any particular and important subject. I do not think that either of these two speakers have these lamps in mind, but I once arranged an installation where even this method was employed. The shop in question had the window generally illuminated with overhead hidden lamps to an illumination of approximately 3 foot-candles, and fixed in the top of the window were several small boxes arranged with powerful lenses, each box containing a 50-watt metal filament lamp, the light from which was concentrated through the lens on to several important articles in the window, which articles, in making the comparison with stage lighting, would stand for the leading actors, and, of course, as in the case of this window lighting, would be the leading points of attraction. The results of this installation were very attractive, and I do not know of any other installation having been carried out on the same lines.

With regard to Mr. Wallis-Jones's suggestion that some experimental observations might be taken in premises when empty, or when a large number of people are present, I think the results obtained would be very similar to those mentioned in my paper of the two windows—one dressed with dark goods, and the other with light. This is one of the factors which makes it very difficult to form a standard of illumination, as the amount of light required must vary with the number of people likely to be in the premises at any one time.

Mr. Shadbolt's remarks as to the personal equation show that this is still another factor to be included among the difficulties of obtaining standards.

Mr. Willcox opened his remarks by saying that he thought it was a hopeful sign to find a station engineer taking interest in illumination. I think if he were to get into touch with the supply authorities, both in London and in the counties, he would find that the individuals concerned were pretty closely interested in this particular subject.

Mr. Willcox also agrees with me that the question of daylight colour value is rather being overdone, and his suggestion of a counter box arranged to give daylight effects for colour matching is quite good.

Mr. Justus Eck makes reference to some enclosed arc lamps of American type shown in some of my pictures. I am afraid I cannot locate these, and think he must be mistaken. I am glad to see that Mr. Eck agrees with me

that indirect lighting is the most desirable form of illumination.

Mr. Leon Gaster's suggestion that the window dressers should be given every consideration, and shown how best to use the illuminants at their disposal, is an extremely important point, and should be one of the first aims of an illuminating engineer.

The trouble suggested by Mr. Dow of the reflections of passing vehicles in the window glass I have never experienced, and I do not think there is very much in this point.

Mr. Plumtree, in his communicated remarks, says he is sorry I did not deal at greater length and more detail with arc lamps for exterior and interior window lighting. I am afraid I am not at all favourably inclined to this form of illumination. As stated in my paper, I am of opinion that such results can be fully obtained with the use of tungsten lamps, and I believe that the over-all cost, including capital and running costs for such illumination, will be found to compare favourably with any method of arc lighting. With regard to his suggestion that powerful metallic filament lamps would be found unsuitable, owing to the question of heat, I do not think that this is a trouble which is likely to occur.

Mr. Darch makes a suggestion that this Society might agitate for the abolition of the extremely powerful unscreened lamps that are placed in low positions outside a number of shop premises in many of our bigger towns. I am certainly in agreement with him on this point, and think that this is a matter which our Society might well advertise as to its many disadvantages. In my opinion no powerful lamp, unless properly screened, should be allowed to be hung outside premises at a less height than, say, 18 ft.

Mr. A. E. Broadberry (*in reply*).—I am very pleased to have an opportunity of replying to the discussion on 'Shop Lighting,' which taken on the whole, has been so kindl in tone and so full of appreciative remarks, that there is little that calls for a reply.

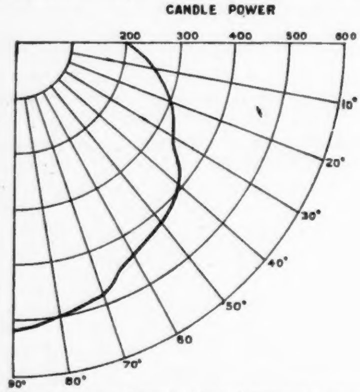
Mr. Haydn T. Harrison did, however, suggest that I had dealt only with outside lighting and high-pressure lamps. This, however, is not quite correct. I gave several instances of excellent low-pressure lighting as well as high-pressure, and inside as well as outside. It must be admitted that far better results can be obtained with high-pressure than with almost any other form of lighting, especially for outside purposes and large buildings such as railway stations, &c.

Mr. Harrison expressed some surprise (and Mr. Wallis-Jones also referred to the same subject) at the great variation from 80 c.-p. at the top of a window to 5 at the bottom; but, with a 600 c.-p. unit placed about 2 ft. 9 in. away from the glass at the top, and, say, 10 ft. from the bottom of the window, these results are exactly what must necessarily be found, and simply confirm the value of the units. The effect would be exactly the same if tests were made with the illumination from some of the flame arcs that are often seen hanging close to windows outside shops.

Mr. Harrison and other speakers advocated the stage style of lighting, because the footlights overcome the comparative deficiency of light at the bottom of the window, as compared with the top, when lighted by overhead outside lamps. In this I quite concur, and if I had foreseen that the question would have arisen, I would have had on the screen a picture of one of our own showrooms, with the window lighted exactly in that way.

The rather dramatic episode introduced by Mr. Justus Eck, when he suddenly drew the veil from his miniature shop window and switched on the current to his two arc lamps, gave me rather a surprise, as I had been told that there were to be no exhibits, and therefore I certainly did not expect one to be revealed so suddenly. The total size of his cabinet could not have been more than 2 ft. 6 in. by 7-in. floor space, and I suppose the candle-power which he suddenly turned on must have been at least a thousand. This is very nearly as high as that used for the whole area in some of the cases mentioned by me, where values as high as 80 foot-candles, &c.,

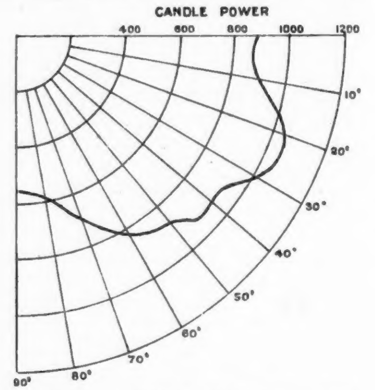
were recorded; and to these Mr. Harrison objected. Mr. Eck did not tell us what the actual candle-power was, but he mentioned that the wattage was about 500; and although I could



Polar curve of Sugg's 3-light "Regent" lamp (low pressure).

not quite judge from where I sat what the actual effect was in the little wardrobe-like cases, I scarcely think Mr. Eck would recommend such a blaze of illumination as being necessary for shop lighting.

I have pleasure in appending the polar curves, not only in the case of the high-pressure lamp for which Mr.

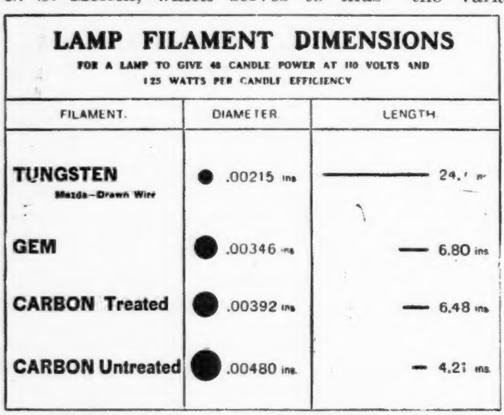


Polar curve of 1,000 c.p. high pressure lamp, with globe and reflector.

Eck asked (taken from a 1,000 c.-p. lamp), but also that for one of the low-pressure lamps referred to in my paper.

The Dimensions of Glow Lamp Filaments.

An interesting comparison is given in the accompanying diagram, prepared by G. S. Merrill, which serves to illus-



COMPARATIVE DIAMETERS AND LENGTHS (IN INCHES) OF VARIOUS LAMP FILAMENTS REQUIRED FOR THE SAME CANDLE POWER AND VOLTAGE AT SAME LUMINOUS EFFICIENCY.

trate in quite a clear manner the relative differences in size and length of filaments of different types of incandescent lamps, from carbon filaments to tungsten. It also shows how lamp filament dimensions are affected by the variations in specific resistance and radiating properties of the various materials employed therefor. It will be noted that there is considerable difference in the length of the Mazda lamp filament and that of the carbon filament.

It is a comparatively easy thing to decide theoretically upon the material necessary to make good filaments, but quite another thing to produce commercial filaments. It is interesting to note that the filaments employed in Mazda lamps are now produced as fine as 0·0007 of an inch for lamps of about 10 c.-p., 100 to 125 volts, and 18–20 c.-p. for 200–250 volts.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

"Zed" Fuses.

We have received from **Messrs. Siemens Bros. Dynamo Works, Ltd.** (39, Upper Thames Street, London, E.C.), an illustrated pamphlet describing some of the special features of "ZED" FUSES. Attention is directed to the risk of using bare-wire fuses in which any size of wire can be inserted irrespective of the requirements of the particular circuit, and it is pointed out that this really affords no adequate protection. The convenience of the "Zed" fuse is emphasized, especially the clearness of the indication of a blown fuse and the simplicity of replacement, due to the use of distinctive colours for fuses of different capacities.

A 10 Candle-Power Drawn-Wire Tungsten Lamp.

Messrs. Siemens Bros. Dynamo Works, Ltd. (Tyssen Street, Dalston, London, N.E.), announce that they will shortly introduce what they believe to be the first metal filament lamp of 10 c.-p. to be made in this or any other country with a pure drawn tungsten filament. It is anticipated that the consumption of the new lamp will be 11 watts, and this high efficiency, coupled with the smallness of the bulb, should lead to its extensive use in cases where carbon lamps have previously been employed. A 16 c.-p. Wotan lamp is also, we understand, to be introduced shortly.

As we go to press, **Messrs. Siemens** inform us that they have now decided to supply 'Wotan' lamps for series burning without the extra charge of 5 per cent which has hitherto been made. This reduction in price will be of interest to the many consumers who are still using low voltage metal lamps in series.

International Smoke Abatement Exhibition.

An important exhibition was opened on Saturday, the 23rd of March, at the Agricultural Hall, under the auspices of the Coal Smoke Abatement Society. The exhibition comprises all the latest appliances for the use of smokeless fuels, both in the home and in the factory, and should prove of equal interest to the housewife and to the business man.

There is a large and attractive display of gas appliances for cooking, for hot water supply, for the heating of houses, shops, factories, churches, and other public buildings, and for furnace work.

Every afternoon and evening demonstrations of cooking by gas will be given with practical hints in the economizing of gas, and in the most effective utilization of cookers, grillers, hot plates, &c. There will also be interesting cookery competitions for school children.

The fogs of London have been largely diminished in intensity of recent years, partly, no doubt, in consequence of the rapidly extending use of gas for fuel; but much remains to be accomplished before the air of London can rival that of Paris or New York, and it is hoped that this exhibition will do a great deal to stimulate the movement in favour of smoke abatement.

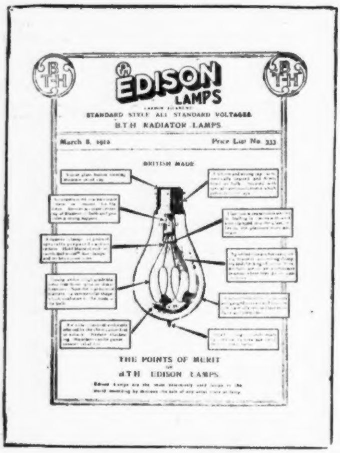
Tickets of admission will be readily supplied by the **Gas Light and Coke Company** to any of their consumers who care to apply at their offices.

Forthcoming Lecture.

Among the forthcoming Friday evening meetings of the Royal Institution we notice, on April 19th, a discourse by A. A. Campbell Swinton, Esq., on 'Electricity Supply: Past, Present, and Future.'

B.T.H. Carbon Lamps.

The illustration herewith shows the front cover design of the new list of B.T.H. EDISON CARBON LAMPS, just issued by the **British Thomson-Houston Company** (77, Upper Thames Street, London, E.C.). This design presents in a striking way the points of merit of the B.T.H. Edison lamps. In spite of the inroads of metal filament lamps, the



carbon lamp is still in demand for industrial purposes, and the B.T.H. Edison lamp is still ordered and used in large quantities.

The new list will therefore be most useful to all carbon lamp purchasers, as it gives complete tables of data on the various voltages, sizes, and efficiencies of carbon lamps in use to-day.

Improvement in Quality of Light given by Mazda Lamps.

In a recent article on 'The Electric Arc and Lighting by Arcs,' published in *The General Electric Review* (of New York), Prof. Elihu Thomson remarks :—

"The marked improvement in incandescent lamps, due to the introduction of tungsten filaments instead of carbon, is not alone one of efficiency, or getting more light for the same energy; there is also the gain in beneficial effect, due to the lessened relative proportion of red rays present, and the closer approximation to daylight."

This is interesting testimony to the quality of the light of tungsten lamps, and shows that such light is not hard on the eyes. Indeed, eyestrain and eye trouble result more from improper use of tungsten lamps—unshaded, low-hung lamps causing intense and glaring light —than from any effect due to the quality of light.

Street Lighting by "Angold" Flam Arc Lamps.

Messrs. the General Electric Co. (67, Queen Victoria Street, London, E.C.) mention among recent important orders for "ANGOLD" MAGAZINE FLAME ARC LAMPS the following: Glasgow, over 170 lamps; Liverpool, 74 lamps. Similar lamps have been supplied for street lighting in Birmingham, Manchester, Sunderland, and several London districts.

Measuring Instruments.

The General Electric Co. have sent us a copy of their new catalogue of MEASURING INSTRUMENTS, in which several new lines have been included.

Some Publications Received.

Street Lighting. By J. M. Bryant and H. G. Hake.—This *Bulletin* (No. 51) issued by the University of Illinois, contains a valuable collection of information on street lighting designed to be of assistance to central station engineers and others connected with the installation and specification of street lighting systems. A considerable section of the bulletin is devoted to the distribution of light, the height and distance apart of lamps being discussed and many examples of polar curves being given. In conclusion, a large number of tables and diagrams are printed showing the cost of operation o various systems.

The Faraday House Journal.—The issue for February contains, in addition to the usual personal notes of old Faraday House students and their doings, a couple of interesting articles, one of which discusses the 'Series-Gear' and its application.

We have also to acknowledge the receipt of the following:—*Proceedings of the Tokyo Mathematico-Physical Society, Journal of the Western Society of Engineers. Transactions of the American Illuminating Engineering Society, Journal of the Royal Society of Arts, American Chemical Journal, Journal of the Franklin Institute, Zeitschrift für wissenschaftliche Photographie Photophysik und Photochemie, Proceedings of the American Institute of Electrical Engineers, Atti della Associazione Elettrotecnica Italiana.*

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

There are quite a number of interesting and varied articles in *Licht und Lampe*, among them being a summary of a paper by O. LUMMER on **Photometry and the Eye.** Reference is made to the action of the retina, the perception of light and colour, and the action of the rods and cones, &c., and particulars are given of a recent form of flicker spectrophotometer.

Among articles of a scientific and photometric trend mention may also be made of the researches of NAVRAT (*Akad. Wiss. Wien Sitz., Ber.*, July, 1911) on **Diffuse Reflection.** He finds that the phenomena are largely dependent on polarization effects, the plane of the reflected light being in some cases dependent on the texture and grain of the surface. J. R. MILNE (*Proc.*, Royal Society, Edinburgh, 1910–11) describes a new form of rotating paddle-wheel to take the place of the rotating sector in photometry. The rotating surface is made in a single piece, and no sliding of one surface over another is needed in adjusting the light.

The paper by T. THORNE BAKER, before the Royal Society of Arts on March 6th, dealt mainly with the spectra of various illuminants, those of the helium and neon tube being shown to the audience. Reference was also made to the production of artificial daylight. Curiously enough, this matter, which was discussed at a recent meeting of the Illuminating Engineering Society in London, has also just been dealt with by Sharp and Millar and Ives at a meeting of the American Society (*Elec. World*, Feb. 24).

ELECTRIC LIGHTING.

ASHTON (*Elec. Rev.*, March 1) gives an interesting suggestion on the **Use of Condensers** in series with glow lamps on alternating circuits to reduce the P.D. This method, he thinks, has several advantages over the more usual employment of transformers. REITZENSTEIN (*Z. f. B.*, Feb. 29) summarizes some recent letters on the "**Overshooting**" **of Metallic Filament Lamps**, recently discussed by Marchant and others in *The Electrician*. He quotes an experiment to show that the basis of this impression is not physiological, as has sometimes been supposed. DUSSAND (*Lum. Electrique*, Feb. 10) describes an attempt to make an incandescent point-source from a piece of thick tungsten wire a few millimetres long for projection work. Special devices are adopted to minimize the effects of over-running and to check the formation of heat. The lamp is brought close to a condenser of very short focus, and is said to be proving very useful for portable lanterns, &c.

HECHLER (*E.T.Z.*, March 21) discusses the possible future improvements in the **Efficiency of Flame Arc Lamps.** An opening is the use of ingredients in the carbons, enabling a shorter arc but a higher P.D. across it to be used.

Finally, there is a very complete contribution on **Street Lighting** by J. M. BRYANT and H. G. HAKE, issued in bulletin form by the University of Illinois. It is too lengthy for any good idea of its contents to be given here, but contains a great deal of useful information.

GAS, OIL, ACETYLENE LIGHTING.

One of the most instructive papers is that by E. W. SMITH (*J.G.L.*, March 26) on **High-Pressure Gas.** Some interesting historical data are given, and the questions of the best pressure for various purposes and the application of high-pressure gas to heating are discussed.

Among other contributions, special mention may be made of the account, in various journals, of the 'Women's Exhibition in Berlin.' Some striking photographs of windows illuminated by concealed gas lights are given.

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CONTRACTIONS (as usual).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*

G. W.—*Gas World.*

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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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EDITORIAL.

The Lighting of Private Houses.

READERS will find on pp. 236-258 the papers on the above subject read by Mr. W. R. W. Rawlings and Mr. W. H. Y. Webber at the last meeting of the Illuminating Engineering Society.

Private House Lighting admittedly differs from such problems as the illumination of printing works, shops, schools, &c., in several respects, and chiefly in the fact that individual taste plays such a prominent part in deciding the method of lighting to be adopted. This point was emphasized by both of the authors and admitted by most of the speakers in the discussion.

At the same time, we think it should also be recognized that there are certain clear and simple rules to be followed in lighting private houses, even if their importance is not always sufficiently recognized by the public. It is obvious, for example, that in a room in which reading and writing is habitually carried on the lamps and shades should be arranged to give sufficient illumination where it is needed, that the light should come from the right direction, and that any conditions likely to be distressing to the eyes avoided. These are matters which were insisted upon in connexion with school and library lighting, and there seems no reason why they should not apply equally well here.

When, however, one comes to the artistic side of the subject, the choice of fixtures, preference for brackets or pendants, &c., the question of individual taste does admittedly enter in to a much larger extent. In such cases the adviser will naturally follow the consumer's wishes as far as possible, and may have to exercise his tact in arbitrating between the wishes of different members of the same household professing divergent views.

On the other hand, we must own we cannot share the views of those who

would apparently recommend the illuminating engineer to acquiesce in an arrangement which he is convinced is not suited to the consumer's needs, and which would obviously be considered absurd by any one with any knowledge of the subject. In many cases the consulted expert must endeavour to press his own views. Presumably people who invite advice on their lighting are willing to listen to it and to be convinced by reason. An illuminating engineer who was willing to assume responsibility for the arrangement of an installation which was entirely opposed to his own views and advice would surely be in a very anomalous position.

To our mind, one reason why so much deference is paid to the whims of consumers regarding these matters is that there are not yet available many lighting engineers who have studied the subject sufficiently to be in a position to take a strong stand. This is not entirely the fault of the contractors who deal with these matters, but rather the result of the fact that there have not been sufficient opportunities for discussing the subject, and on many points there is as yet no authoritative ruling to be obtained. If, however, the consulting engineer had behind him the weight of impartial and authoritative opinions on these matters he would be in a much stronger position in the future. For this reason we welcome Mr. Rawlings's concluding remarks, in which he points out the benefit to the contractors of educating themselves in illuminating engineering.

Moreover, a little consideration will show that it is on these very questions of "taste" that advice from some one with an artistic bent is most valuable. As regards purely utilitarian considerations the matter is more simple, because it is possible to state precisely what the light is expected to do (*i.e.*, to illuminate a table, a flight of stairs, or a sink in the kitchen), and to devise rules accordingly. But it is not every one who is gifted with the artistic sense, and those who seek advice are usually aware of this.

Yet another matter which deserves careful consideration in connexion with the lighting is the effect of wall-papers of various colours, the furniture, and the style of decoration generally. Not only has this an important effect on the actual illumination in a room, but it is likewise an element which must be borne in mind in deciding the nature of the fittings, shades, &c.

There is certainly room for a great deal of discussion on these æsthetic matters in the future. Meantime the expert who devotes himself to this special aspect, and can prove his competence to advise on decoration and lighting *conjointly*, is likely to reap the reward of his foresight very shortly.

The Lighting of the House of Commons.

From some remarks that were recently made in the House of Commons, it would appear that the lighting of that building is now being considered with a view to possible improvements. It is interesting to recall that in the past the authorities responsible showed themselves extremely averse to any radical departure from the existing conditions ; so much so that when, in the early days of the nineteenth century, Dr. D. B. Reid suggested the introduction of gas, he was met by the imperative instructions, "Do what you will for the acoustics and ventilation, but take it as a fixed and settled point that wax candles remain !"*

In a question in the House on this subject Mr. Lynch inquired whether, under certain conditions, electric light was not more fatiguing to the eyes than gas-light, and suggested that expert advice should be obtained. Mr. Wedgewood Benn, on behalf of the First Commissioner of Works, stated that it was proposed to obtain the advice of an oculist on this point.

* *Illum. Eng.*, Lond., vol. ii., 1909, p. 665.

There, for the present, the matter remains.

In a recent letter to the *Times* the writer took the opportunity of pointing out the unsatisfactory nature of the proposed course of apparently taking the advice of a single oculist on a point of this kind. The matter is not one which should be left to the judgment of a single individual, however eminent in his profession he may be. The effect of illumination on eyesight is a subject which can only be properly investigated by the concerted efforts of lighting engineers as well as physiological experts, and there are certainly few (if any) existing oculists who have made a sufficient study of the matter to give an authoritative ruling. Lighting engineers are well aware how greatly the effect of an illuminant on eyesight depends on how it is used, and insufficient stress might easily be laid on this aspect by those unfamiliar with the most recent advances in illuminating engineering. It need hardly be said that considerable weight would be attached to a decision in the case of such an important building as the House of Commons, and the matter is therefore one of some importance to the lighting industry. Consequently we hold that special prudence should be exercised before a definite opinion is issued.

Moreover, the particular point raised by Mr. Lynch is one that is constantly occurring in connexion with the lighting of all manner of buildings. To our mind it illustrates the need for a broad and impartial inquiry into the hygienic aspects of lighting by a committee similar to that constituted by the French Government. We hope that it will not be long before steps are taken to form such a Committee in this country.

Finally, we should also like to point out that the question of the effect on eyesight, though doubtless an important matter, is far from being the only consideration by which the lighting of the House of Commons should be decided. The illumination should not only be ideal from the æsthetic standpoint, but should satisfy the practical needs of the House. Surely the illumination of an historic interior of this kind is a matter deserving a little special study. One would have supposed that the best advice in the country would be sought in order to make it worthy of the House of Commons, just in the same way as would doubtless be done if the question of the rebuilding had to be considered.

The Eyesight of Miners.

We notice that a recent inquiry has been addressed to the Home Secretary with reference to the Eyesight of Miners, particularly the nervous defect known as "nystagmus," which, it is suggested, is in some measure the result of the peculiar conditions of illumination under which work in mines is carried on.

It may be mentioned that at the time of the Congrès International des Maladies Professionnelles in Brussels in 1910, several papers were read in which allusion was made to this subject. One suggestion was that the peculiar attitude often necessarily assumed in his work by the miner, which compels him to look obliquely at the spot he is drilling, might lead to this ocular defect.

Dr. J. Court, of Staveley, who has been studying the subject, has now come to the conclusion that it is due to the defective illumination of the miners' lamps (presumably because this increases the strain of observing the feebly lighted surroundings).

It is natural that the Home Secretary should regard the matter as an important one, affecting as it does the lives of a vast number of men in their daily work. We have always felt that the murky conditions in mines called for particular care in the selection of lamps and methods of illumination. Greater attention now appears to be paid to the matter, and it seems highly probable that fuller examination will

show that defective illumination is at least a partial cause.

We are glad to notice that the matter is about to be taken up. We venture to suggest that it is one which might well come within the scope of the Committee on the Hygienic Aspects of Lighting which, as mentioned above in another connexion, we strongly desire to see constituted in this country.

Lighting Appliances and the Safety of Large Vessels.

At the present moment, when the minds of all are oppressed by the terrible disaster and loss of life on the Titanic, we are not anxious to criticize nor to place undue stress on the neglect of precautions which apparently renders such catastrophes possible.

At the same time, we feel that in a case of this kind the least one can do is to try to learn a lesson from disaster and to take all possible measures to prevent its repetition. From the inquiry so far conducted, several points stand out as deserving attention. For example, that fuller use might be made of the great advantages of wireless telegraphy and more perfect arrangements organized as regards boats and life-saving apparatus; also the value of searchlights as a means of detecting possible obstructions in time to avoid collision. It is with this last point, and with some other uses of light on board ship for purposes of safety, that we desire to deal.

There seems to be a very general opinion that the use of a searchlight might in this case have assisted the look-out man to observe the iceberg, and give timely warning. Moreover, in all cases in which obstacles are likely to be met, whether semi-submerged rocks or icebergs, this would surely be the case. We do not suggest that ships should habitually use their searchlights when in no danger in the open fairway; under these circumstances there might be a danger of their confusion by other vessels with fixed lights. But in dangerous waters and amid ice-floes their value seems evident; and it is obvious that even an ice-barrier which projected only slightly above the surface of the water would become quite a prominent object when strongly illuminated. Moreover, it may be pointed out that, within a limited range, a searchlight is a most useful means of getting in touch with other vessels and signalling for assistance.

Another matter which, to our mind, is equally important in the interests of safety is the provision of adequate and alternative methods of illumination on board ship. Adequate provision in this direction was, we presume, made on board the Titanic. A poor illumination in the humbler parts of the vessel constitutes a continual source of inefficiency, and extra emergency lighting should be provided. It needs little imagination to picture the confusion and inevitable delay in launching boats in darkness when the light has failed on a sinking ship. It would also be a good plan if the boats were also equipped with some portable lighting apparatus (such as dissolved acetylene) which would enable them to make their presence known to passing vessels, to avoid collision with other boats, and to recognize floating passengers in urgent need of help.

We have reason to believe that these views are held by many captains and officers. They are quite alive to the necessity of lighting improvements, but unfortunately it is often very difficult for them to get their requirements carried into effect. Let us, therefore, take this lesson to heart, and neglect no obvious means of lessening the risks at sea in the future.

LEON GASTER.

Review of Contents of this Issue.

THE Technical Section opens with an abstract of a paper by G. H. STICKNEY on **Localized and General Illumination** (p. 225). The author points out that these two systems of lighting represent extremes which were formerly very clearly distinguished, when either arc lamps or incandescent carbon lamps were used. The tungsten filament lamp has, however, provided an intermediate range of units, and has therefore been applied to installations where a combination of localized and general illumination is required. The author considers each system of lighting separately, and draws attention to the difference between combined localized and general illumination (in which large units provide most of the light, but are supplemented by small units at particular points) and what is termed "localized-general illumination," in which units of medium size are arranged regularly, but yet with special reference to the machinery or process requiring extra light. At the end of this article will also be found a short note dealing with the application of **Indirect Lighting in a Club,** and allusion is made to a recent suggestion that the discomfort of the average club smoking-room is due largely to the use of a glaring system of illumination.

Page 228 is given up to several short notes. Some interesting examples of the effect of an eclipse on birds and insects are quoted, and the inference is drawn that variations in daylight must strikingly affect our daily life.

A brief report is also given of a recent lecture by Mr. J. W. Johnston on **Early Methods of Producing Light,** in which many ancient and primitive forms of lamps coming from Egypt, Nigeria, and other countries, were exhibited, and also more elaborate illuminants from China, India, Corea, &c.

Reference is also made to the suggestion, which has attracted some attention, as a result of the disaster to the Titanic, that all large ships of this kind should be equipped with searchlights, in order to enable icebergs or other obstacles to be detected in ample time to avoid a collision.

At the beginning of the section devoted to the Transactions of the **Illuminating Engineering Society** (p. 229) will be found the complete discussion on 'The Lighting of Printing Works,' an abstract of which appeared in the last issue. On p. 235 is a report of the meeting on April 16th, at which papers were read by MR. W. R. RAWLINGS and MR. W. H. Y. WEBBER on **Private House Lighting by Electricity and Gas** respectively, and this is followed by these two papers *in extenso*.

The first paper deals largely with the application of electricity to the lighting of large country houses and town mansions, the points brought out by the author being illustrated by a large number of photographs, which are described and commented upon.

A distinction has to be drawn between the requirements of different classes of houses. It is instructive to notice how the standard of illumination demanded in town exceeds that desired in the country, but the average illumination everywhere has greatly increased during recent years.

Some general rules for house lighting are also given, and the author points out the diversity of opinion existing among the users of electric light as to the actual amount of light required in a given place, and alludes to the fact that in choosing fittings and placing lights individual tastes had always to be considered. Attention is also paid to certain specific problems, such as the lighting of billiard tables and pictures, for which special fittings are desirable.

In conclusion, stress is laid on the importance of the studying of illuminating engineering to the contractor in enabling him to assume a more independent position.

Mr. W. H. Y. Webber, in his paper (p. 250), treats the subject mainly from the point of view of the middle-class householder. He emphasizes the importance of regarding the illumination of the home, not so much as a question of so many foot-candles, but from the standpoint of picturesqueness and comfort. On the other hand, a certain illumination of the order of 3–4 foot-candles is, of course, necessary for certain specific purposes, such as reading. He briefly reviews the history of gas lighting in the home, and draws attention to the great changes effected by the introduction of the gas mantle, and especially the inverted burner. The uses of the flat-flame burner are still many, however, *e.g.*, on stairs, in passages, and in general as a safety light. A plan of a small £40 a year house is reproduced, and on it the author indicates a suggested arrangement of gas burners for the different rooms. He describes his proposals in detail, and raises several points with regard to the utilization of gas burners for lighting different classes of rooms. A series of illustrations of gas-lighted interiors is given, including an example of the use of "bijou" burners for illuminating a billiard table.

Following the Transactions will be found some account of the **International Smoke Abatement Exhibition** held recently at the Agricultural Hall. A feature of special interest was the section arranged by the Electric Supply Publicity Committee, in which lighting, cooking, heating, &c., were all carried out by means of electricity. The lighting of the hall was arranged mainly on the indirect system, three separate sections being lighted by fittings supplied by different firms. Small silk-shaded lamps were also used on the small tables, and Holophane glassware was used round the sides of the room. Two photographs, taken entirely by the actual artificial light, are reproduced showing the effective illumination thus obtained.

Other points of interest included the joint exhibit of the various gas companies, where gas cooking demonstrations were given, the lighting of the main hall by incandescent gas lamps placed high up, and an exhibit by the Union Electric Co. of shop lighting by concealed arc lamps.

On p. 260 are shown some striking photographs of Shop Lighting at the Women's Exhibition in Berlin. It is of interest to note that the arrangement of the lighting of these windows by "concealed" methods and the design of the lighting fixtures were specially devised by lady artists in Berlin, Grätzin gas lamps being used throughout. In one case the burners were equipped with a new concentrating reflector for which special qualities are claimed for producing a flood of light on the goods.

In the Correspondence Columns (pp. 264 to 266) appears a letter from Dr. Clayton H. Sharp, in which he draws attention to a form of apparatus used by him for the obtaining of polar curves of light distribution, similar to the apparatus described in our issue for January by Messrs. J. S. Dow and V. H. Mackinney. He mentions the difficulty found in measuring and allowing for stray light, and refers to one or two other points, such as the desirability of using a distance of 10 ft. in testing "focussing" forms of reflectors. A brief reply from Mr. J. S. Dow follows. There is also a letter from Mr. Max Peschke on the subject of **Colour-Discrimination by Artificial Light,** in which he refers to some experiments carried out with various forms of colour matching apparatus. He also mentions some results obtained in the imitation of daylight by the use of colour filters consisting of the combination of cobalt-blue and nickel-green glasses, and in conclusion points out the need for a more exact definition of what constitutes standard daylight.

At the end of this number will also be found the **Trade Notes**, and the usual **Review of the Technical Press.**

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

Localized and General Illumination.

BY G. H. STICKNEY.

(Abstract of paper presented at the October New York meeting of the American Society of Mechanical Engineers; see also *American Machinist*, Nov. 2, 1911.)

LOCALIZED and general illumination mark two extremes of lighting practice. A few years ago, when practically all electrical illumination employed either the arc lamp or the carbon-filament incandescent lamp, the line of demarcation was more distinct, and practically all industrial lighting was accomplished with the incandescent lamp as localized illumination, or with the arc lamp as general illumination.

We have, however, now four classes of practice in shop lighting, namely:—

1. Localized illumination with small lighting units.

2. General illumination with large lighting units.

3. Combined localized and general illumination with both large and small units, and

4. Localized - general illumination with units of intermediate capacity.

LOCALIZED ILLUMINATION.

Localized illumination usually implies a carbon-filament incandescent lamp, or other small unit, hung over a machine or bench, mounted on a bracket or used as a portable. The lamp is usually under control of the workman, who (presumably) places the lamp so as to direct the light where needed. The area illuminated is relatively small, and the intensity falls off rapidly from the point of maximum illumination.

While localized illumination is being superseded in many cases by what I have called "localized-general illumination," it is particularly suited to certain conditions of manufacture. For example:—

(*a*) Illumination of deep borings, moulds, interiors of cupolas, under or inside of machines, or other places where a general illumination could not well penetrate.

(*b*) Illumination of straightening or inspecting processes, where the image or reflection of the light is specially employed.

(*c*) Illumination of very fine work, such as small-screw thread cutting, jewellery work, machine sewing (on dark goods), where an intense illumination is required over a small area.

Localized illumination is most economical where the surfaces to be illuminated are relatively small and widely separated.

As a rule a workman will choose this form of illumination, since the lamp is under his own control. Usually, however, he does not use it to the best advantage. Frequently he arranges the lamp so as to cast a glare in his own eyes or those of his fellow workmen. This results in eye strain and a demand for more intense illumination than would otherwise be necessary.

The common practice of using lamps without reflectors is not only wasteful of light, but makes it almost impossible to avoid glare.

Besides diverting the attention of the workman, the localized lamp, being sometimes held in his hand, precludes the utilization of that hand in his work.

Such lamps are often exposed to considerable breakage, and although low-priced lamps are used, the renewal cost is high. This, combined with the wear and tear on the extension cords, sometimes results in excessive maintenance expense, especially as the small unit makes necessary a large number of outlets.

General Illumination.

With general illumination an attempt is made to provide an approximately even intensity of illumination throughout a workroom. This ideal is never quite realized, except, possibly, when the lamps are hung at a considerable height. The intensity directly under, or in the immediate vicinity of a lamp is almost invariably higher than at intermediate points.

Lamps are usually spaced equally throughout a room, independent of the location of machinery; hence no change in wiring is required by any changes that may be made in the position of machines. The most efficient illuminants are available, and since there are fewer outlets required, the initial wiring cost and maintenance expense are likely to be relatively low.

Where work is concentrated, requiring a particular intensity over a large proportion of the floor area, general illumination will usually cost less than localized lighting. The effect in the room is much more cheerful, and the foreman is enabled to exercise better supervision over his entire department.

General illumination is best suited to large high shops, especially where crane-ways require the location of the lighting units along the sides of the room or above the cranes. General illumination is especially desirable, on account of safety, where large powerful moving machinery is used. It is commonly used in rolling mills, large, high machine shops, erecting bays, iron foundries, carpenter shops, and similar places.

Combined General and Localized Illumination.

There are many shops in which a low or moderate intensity will answer most requirements, but where a higher illumination is required either at a few localized points, or only occasionally. In such cases the combination of large and small units has often been used to good advantage. For example, a group of automatic screw machines requires but a moderate general illumination when in operation. But when a workman has occasion to set up or adjust one of these machines, a more intense illumination is required at that particular point. This can best be taken care of usually by a combined general and localized illumination.

For this particular purpose, since a workman ordinarily attends to a number of these machines, it is good practice to provide him with a lamp and short extension, arranging the wiring so that the extension can be connected or plugged in at convenient points near the machines. There are many variations of this practice, according to the requirements of particular shops.

Localized General Illumination.

I have applied this term to the practice of producing general illumination by means of units arranged regularly, but with reference to the machinery or processes to be lighted, so as to provide a higher intensity of illumination at important points than elsewhere. The units are located also with regard to giving suitable direction to the strongest light on a certain machine, thus avoiding objectionable shadows and reflections. The size of unit is selected to suit the spacing and amount of light necessary.

This practice has followed directly as a result of the development of the tungsten filament lamp, which made available a series of efficient units throughout a range of capacities for which no provision had previously been made. This type of illumination is now being used to a very large extent for looms, lathes, and other machinery where the size and spacing of the machines is such as to permit fairly uniform spacing of lamps. It is also suitable for processes where lamps can be spaced over lines of benches or work tables. By varying

the height, spacing, and size of unit, as well as the type of reflector, practically any character of distribution of illumination of suitable intensity can be obtained, ranging from the extreme of localized illumination to that of general illumination.

This class of practice embodies, in a measure, the advantages of both localized and general illumination. It may really be said to bridge the gap formerly existing between these two extremes, and is made particularly effective by the ability to select units of any desired capacity and equip them with reflectors which concentrate or spread the light over wide or narrow angles.

Localized-general illumination is distinct from localized illumination, in that the lamps are located higher and are not usually controlled by the individual workman, and from general illumination in that the points of maximum intensity are located to suit the arrangement of machinery or other processes.

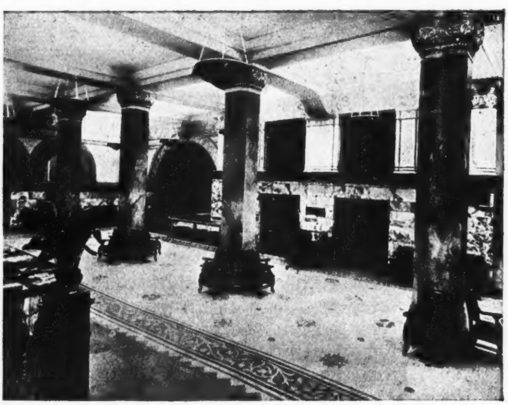
CONCLUSION.

In the foregoing we have briefly outlined four different classes into which the practice in industrial lighting naturally divides itself. The development of new, efficient units has, in many cases, made a readjustment desirable, so that a large number of shops are changing from one class of practice to another. Nevertheless, there are conditions, as we have already noted, which, at least for the present, will make it desirable to continue with each of the four classes.

It is hoped that these notes will be of assistance in the selection of the most suitable practice for particular lighting problems. Since cost of satisfactory illumination will frequently be the determining factor, it is urged that the determination be made on the basis of actual installation conditions. The number of possible combinations is so large, and the advantage of certain combinations, for particular reasons, so marked, that the advice of an experienced illuminating engineer is necessary to insure the selection of the most suitable arrangement.

Indirect Illumination in Clubrooms.

THE accompanying illustration, showing the "Eye-rest" system of the British Thomson-Houston Co. utilized for club-lighting, is interesting in view of a suggestion in a recent book by Mr. Harry Graham, who says that the discomfort of the ordinary club smoking-rooms is mainly due to defective lighting. "It is impossible to sit in such a position that you do not stare into the heart of a glittering mass of electric globes. It is impossible to be cosy in such circumstances."



By the method shown in the figure the glare is avoided by the indirect method of lighting, special ornamental metal or plaster bowls containing Mazda lamps being utilized.

Doubtless there is much still to be done in improving the lighting of the average club smoking-room.

The Eclipse of the Sun in London.

On April 17th Londoners had an exceptionally good opportunity of seeing an eclipse of the sun. About 92 per cent of the disc was obscured, and the cloudless sky was particularly favourable for observations.

Illuminating engineers and others whose minds are constantly occupied with the effects of light are naturally interested in the peculiar effects accompanying an almost total solar eclipse. Several of the daily papers recall the conditions observed at the time of the great solar eclipse of January 22nd, 1898, and some amusing incidents are described which illustrate the direct influence of light on animal life. For example, fowls went to roost when the darkness came on, and monkeys in the Zoological Gardens climbed to the top of their cages and prepared for sleep.

In the same way it is recorded that during the eclipse of August 30th, 1905, bees and ants were observed to cease work and go to sleep at the period of totality, awakening and renewing their activities again when the sun's disc once more began to appear.

Lamps of Many Ages.

On Thursday, March 28th, a most interesting lecture, entitled 'Light from the Earliest Times and Various Methods of Producing It,' was given at the Church House, Hendon, by Mr. J. W. Johnstone, in aid of the Hendon Parish Church Enlargement Fund.

Old fire-sticks, tinder-boxes, rush-lights, and "puirmen" were included among the exhibits, and quite a number of specimens from the lecturer's collection of lamps, coming from Egypt, Rhodesia, Scotland and Venice, China and Japan, Corea, &c., were also on view. Some of the more primitive lamps were curious in the extreme, while the design of the later forms was often extremely artistic. It can hardly be questioned that the lighting engineers and fixture-designers of to-day would learn much by studying these ancient illuminants, and tracing the gradual modifications in their design according to the local traditions.

On the other hand, it would appear from the researches of antiquaries that in many countries—ancient Egypt, for example—people continued to make their little primitive lamps in exactly the same way for hundreds, or even thousands of years—a most remarkable contrast in comparison with the activity of the last decade !

The Use of Searchlights for Detecting Icebergs.

Among the many suggestions which have been made as a result of the appalling disaster to the Titanic, one of the most important relates to the use of searchlights. It is pointed out that a powerful searchlight might lighten the work of the look-out, and enable an iceberg, or even a comparatively small projection above the surface of the sea, to be visible at a sufficiently great distance for the vessel to shape her course in time to avoid it. It would, in fact, play the part of the headlight of a motor-car on land, and might well be adopted by all large vessels, particularly those which habitually make their way through iceberg regions. Were this done, it is suggested, the risk of collision in clear weather would be reduced to very small proportions, while in misty and foggy weather the searchlight beam would also be of very considerable assistance.

TRANSACTIONS
OF
The Illuminating Engineering Society
(Founded in London, 1909.)

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.)

The Lighting of Printing Works.

DISCUSSION.

[Discussion of two papers by Mr. F. W. Goodenough and Mr. Justus Eck on the Illumination of Printin Works by Gas and Electricity respectively, read at a meeting of the Illuminating Engineering Society, at th House of the Royal Society of Arts (London), on Tuesday, March 19th, 1912. See *ante*, pp. 171-200, April, 1912.]

THE CHAIRMAN congratulated the Society on having received papers containing such valuable results obtained by two independent investigators. He noticed that there were a large number of visitors, which, he understood, included representatives of the Printers' Association, and the Institute of Printers or Lithographic Printers. He also hoped there were present representatives of some of the printing firms, daily papers, and other important journals. He trusted these gentlemen would realize that a Society like this was always glad to have views as to the requirements of various people actually using light in connexion with the subject of the papers, and therefore that they would join in the discussion.

MR. FRANK BAILEY (Chief Engineer of the City of London Electric Lighting Company) said he had visited many of the works depicted on the lantern-slides at various times in connexion, not with lighting, but with driving the plant by electricity. He could, however, speak of the benefits of good lighting in these places, not only as to the facility of work, but as regards the greater comfort of the workers. He would like to know if any complaints had been made to the authors as to the effect upon the eyesight of the workers from the numerous forms of lamp, such as the mercury lamp or the incandescent lamp, because there existed the idea that the metal filament lamp was the cause of eye trouble. It seemed from the slides of many of the installations that no greater care could have been taken in protecting the eyes.

MR. F. W. WILLCOX, of the British Thomson-Houston Co., congratulated the authors upon having presented so many practical examples of both good and bad illumination, because by studying the bad installations it was easy to learn what was necessary to make a good one. One fact which stood out from Mr. Eck's paper was the importance of engineering in illumination, and the value of this Society to all classes of industry in which lighting was a factor. Mr. Eck's examples showed clearly the very remarkable need of a change of position in the lamps, and the need of a better reflector equipment for lamps. There was also need for a proper understanding of what constituted a good reflector. Many people thought that because a piece of tin or porcelain would reflect light, that therefore any old paper or opal shade would serve to use over a lamp. A great advance was made, however, in the cause of good lighting when a scientifically designed reflector was produced which permitted the distribution of the light to be varied to suit any particular conditions. Such varied distribution of light was not possible, however, from a tin, paper, or ordinary conical opal reflector, and the usual effect of such reflectors was to require lamps to be placed very low down in order to get light upon the work. As was seen in the example shown by Mr. Eck, the effect of such reflectors and low hung lamps was to throw the upper part of the room in darkness. Such a condition of light was responsible for eyesight troubles. He congratulated Mr. Eck upon his excellent results with indirect

arc lighting, but at the same time wished to point out that equally good results could be obtained with an indirect lighting system employing metal filament lamps.

Mr. Willcox added that he was sorry not to be able to show some examples of indirect lighting with metallic filament lamps in printing shops. Such a system, however, had been very successfully employed—the well-known eye-rest system and X-ray reflectors. One of the very largest publishing houses in the United States, the Curtis Publishing Company, after a year's careful testing by a committee of five, decided on this eye-rest system of lighting as the most desirable for their new building and offices. The points considered were (*a*) original cost, (*b*) cost of operation, (*c*) maintenance cost, (*d*) depreciation, (*e*) seeing efficiency and visual acuity. This was probably one of the largest installations ever made of one single type of lighting fixture. Equally good results were given by this indirect lighting system as with the indirect arc lighting, and the simplicity, general adaptability, and many advantages of metal filament lamps would make this system of lighting very widely used.

Mr. P. J. Waldram discussed the question of daylight illumination, which he thought was of importance in considering the question of efficient illumination. There was not the slightest doubt that work done under daylight conditions was very much better in every way, especially where the light was received from above and not at the side. As an example, he mentioned the case of a printing works in the neighbourhood of Blackfriars which he investigated, where late in an afternoon in October, when the street lamps were actually alight on Blackfriars Bridge, the men were at work by daylight through roof skylights, although the latter were very dirty. This emphasized the point that the angle at which the daylight reached the worker was far more important than anything else. More working light could be got through an old roof skylight than a very large window at the side which allowed the light to fall in a horizontal direction. It was of the utmost importance that daylight should reach the worker in a direction nearly vertical, if possible, from about ten degrees from the zenith; and the nearer these daylight conditions were approached, the later could they turn on artificial light. Moreover, as these conditions were found to be best for daylight, they ought to be equally good for artificial light. It was also important to attempt to approach this condition of direction as it was to approach in artificial light the conditions of the spectrum. Therefore, he would expect that indirect reflected light would in many cases give the best results in the long run. Mr. Eck had suggested that the spectrum of the light should approximate to that of daylight, and be as near white as possible. He would like to know the reasons for this, because it was possible to do good work quite late in the afternoon, as far as printing was concerned, when the light was apparently not white, but of a red tinge; and also early in the morning, when the light seemed to be very yellow shortly after dawn, when the men had been working all night.

Mr. T. E. Ritchie said that a point to be studied in connexion with indirect lighting units was the tendency, in quick printing, for a fine deposit of ink to settle on the reflecting surfaces, naturally causing a certain loss of light. In the case of indirect arc lighting such deposits settled mainly on the top of the reflector, which was not used to direct the light, and they therefore did no harm.

In conclusion Mr. Ritchie referred to Mr. Waldram's remarks on daylight, pointing out that it had been shown by Dr. Kenneth Mees that the quality of the light varied only to a very small extent during the course of the day. This

was the experience of artists, who found themselves able to match colours with the same results at sunset as at midday.

Mr. M. Foulds referred to the question of the effect of various lights upon the eyesight. Probably the greatest effect upon the eyesight from any form of artificial illumination was due to glare, and Mr. Eck had mentioned instances where people had been able to abandon spectacles since the adoption of indirect lighting by means of arc lamps. Instances could also be quoted of the same effect where monochromatic light had been adopted. He did not suggest that this effect was altogether due to the colour of the light, but in a large degree it was due to the better diffusion that had been brought about by improved lighting methods.

Mr. G. W. Mascord referred to an early installation of electric lighting put in upon the premises of his firm by Messrs. Crompton & Co., and mentioned that the effect in comparison with the previous use of gas was so marked in decreasing the temperature of the machine room, that this first installation of electric light was immediately extended to the whole building. Since then, however, important improvements had been made in gas lighting, with the result that probably, if he had to start over again, he would be in great doubt as to which system to adopt. In his premises at the present time there were 3,000 incandescent lamps and 100 arc lamps, illuminating about 3½ acres, and he would leave it to the members to work out for themselves the probability of this area being suitably supplied with light. Although electric lighting had given improved results over the older system, yet it was fair to point out that, when the building was rearranged, they also changed the character of the internal decorations by putting up white tiles and distempering and painting elsewhere in suitable colour, which, of course, added greatly to the general efficiency. *The Daily Chronicle* had also installed what he thought was the first batch of the commercial type of Westinghouse Cooper-Hewitt mercury vapour lamps brought over to this country, but the results were not particularly satisfactory, and they were turned out. Later on Mr. Foulds brought over the newer lamps, and asked him to try them. With the previous experience in mind, he refused to have them installed unless put in solely at the makers' cost and risk. This was done, and the results were so satisfactory that the workmen sent a request for them to be retained, and they were still in use to-day. The compositors working with these lamps were working under extremely trying conditions. They went on at 5 o'clock in the afternoon, and worked until 2, 3, 4, or 5 o'clock in the morning, as the case might be; yet in one or two cases men who wore spectacles had since discarded them. The lamps used about one-half of the current compared with the carbon filament incandescent lamps previously in use, but gave infinitely better lighting effect. On the whole, he thought that a thoroughly well-diffused light was the best condition to work under, and he had satisfactory evidence of that. In one room, where they had at one time some 250 incandescent lamps, these had been replaced by inverted arc lamps; and though the men complained strongly that they were afraid the result would not be satisfactory, the incandescent lamps were all taken out. Nine inverted arc lamps were put in, and now the men swore just as strongly by the inverted arc lamps as the men in the other room did by the mercury vapour lamps.

Mr. Mascord stated in conclusion that, apart from the question of which particular method of lighting was adopted, in his opinion plenty of well-diffused illumination was a paying proposition for all concerned.

Mr. V. H. Mackinney expressed his agreement with Mr. Goodenough's remark that what was needed was not only the provision of a certain illumination in foot-candles, but of a certain "seeing power." It would be very useful if one could devise some ready means of estimating this visual

effect. Something in this direction had already been done in the United States by Mr. A. J. Sweet in his researches on glare.

He thought that the figures given for the watts per foot-candle per square foot of surface illuminated, given by Mr. Eck in Table 6 (p. 190) could only be stated in very general terms. It would perhaps have been well to have specified more exactly, in the headings of the table, how the glow lamps were used (*e.g.*, with opaque or prismatic reflectors), as this would naturally make some difference in the result. Again the lightness or darkness of the surroundings and other local circumstances might make quite as much difference as that stated to exist between the various systems of lighting. He did not quite follow Mr. Eck's remarks on maintenance (p. 191). It was surely incorrect to assume that the maintenance costs of different electric installations could be regarded as proportional to the wattage, irrespective of the system of electric lighting employed.

In conclusion he thought it was of interest to mention, as showing the valuable work being done by the Society, that shortly after the announcement of these papers, and before they had actually been read, he had received quite a number of inquiries on the subject of printing works lighting from people anxious to make improvements.

Mr. Guy Campbell, in a few remarks, said that he had been struck by the fact that there was much haphazard work in connexion with the illumination of printing works, judging from the photographs which had been placed upon the screen. While acknowledging the valuable work of the Society, he would also like to refer to the pioneering efforts of several companies in this country, which should be thanked for the great assistance given by their illuminating engineering departments.

Mr. Leon Gaster explained that the Society had taken the opportunity of inviting to the meeting a number of associations interested in printing matters, including the Master Printers' Association, Institute of Printers, the London Society of Compositors, and the Amalgamated Society of Lithographic Printers, and he had received several letters expressing a keen interest in this subject.

One question which he thought might well receive more attention than at present was the effect of artificial illumination on the eyesight of workers in the printing trade. In his opinion many difficulties in this respect were due not to the illuminant, but to imperfect methods of shading, and the employment of lamps in incorrect positions.

He might mention that in Milan there already existed an institute devoted to industrial hygiene, and Dr. Carozzi, who was connected with this institution, had recently been conducting a series of researches into the hygienic conditions in printing works.

But, quite apart from this standpoint, it was surely an uneconomical practice to instal the best modern printing machinery at great expense, and then to be content with antiquated methods of lighting.

The Chairman, referring to Mr. Mascord's remarks upon the whitewashing of the building when the change of illumination was made, said it was a pity that he did not test the new lamps before whitewashing, as that would have given a most valuable comparison. In his personal opinion, the inverted gas lamp took a lot of beating when lighting such things as compositors' frames, where the illumination had to be very high owing to the surface illuminated being nearly black.

When they all had time to compare the figures in the two papers, it would be seen that many of Mr. Goodenough's figures were very high indeed; and though there were cases where too much light could be produced, in his opinion there was not a single case where they could have too much light on a black surface. In such cases the high illumination mentioned by Mr. Goodenough would be very much appreciated.

MR. J. S. DOW (*communicated*).—A distinct advantage of indirect lighting systems is doubtless the ease with which light can penetrate into remote corners. On the other hand, it appears just possible that this very quality might not be the most suitable for illuminating compositors' frames, and for tables on which type is examined. In such cases, one might suppose, light coming from a small source and therefore casting fairly sharp shadows, would be preferable in distinguishing and picking out from the frame small type. But light coming from a very extensive area would naturally be better for getting into crannies and illuminating complicated machinery.

Another matter that deserves attention is the direct reflection from the type. This is found to be particularly troublesome if the lamps are not judiciously placed. In the case of newly cast bright metal, the direction from which the rays from a local lamp come is important. As previously described in this journal, at the Arts and Crafts School a very excellent method with the lamps well shaded and placed on the left hand is employed. In my opinion it should be absolutely impossible for the worker to see the actual source of light in such cases, and I venture to suggest that some of the examples shown by Mr. Eck and Mr. Goodenough are open to objection on this ground (*e.g.*, Fig. 3, p. 173 ; Fig. 6, p. 1911).*

MR. JUSTUS ECK (*in reply*).—The discussion of my paper has been most interesting, and I think the best method is to deal with the remarks and questions of the speakers *seriatim*.

I can assure the society that the mercury vapour lamp is well liked wherever installed, and its low specific brilliancy, like that of the indirect arc lighting secondary sources, seems unlikely to injure the eyesight.

I agree with Mr. Willcox that better results and greater comfort are obtained from indirect than direct light by metal filament lamps, but the arc lamp lighting presents advantages not obtainable with metal filament lamps in the way of colour discrimination, which is of paramount importance in colour printing, lithography, &c. Incandescent lamps require colour filters, absorbing somewhere about four-fifths of the light which therefore render their use, on the score of economy alone, impracticable. Everybody will agree with Mr. Waldram's remarks as to the advantage of skylight lighting, and I need hardly point out that the equivalent to this from an artificial source is indirect lighting by arc lamps.

As an authority on practical printing, as to the Mr. Mascord's testimony, value of liberal and well-diffused lighting, must command our attention, especially as it differs from the impression in some people's minds that spot lighting is desirable for the compositor's bench. Mr. Mascord's experience with so many systems of lighting makes his pronouncement carry the weight of a considered judgment, which should prove of utmost value to many printing engineers and managers. I am not without hope that "a ready means of estimating" "seeing power" will, before long, be available, and doubtless it will convert many unproved beliefs and statements to actual recorded facts.

With reference to Mr. Mackinney's further criticisms, all the examples referred to in the tables were illustrated both in the slides shown and in the printed papers in the hands of the audience, and show the actual existing conditions in each case, and furnish, with the possible exceptions of those cases where the light was insufficiently good to show anything, the information which Mr. Mackinney suggests might have been supplied.

I do not agree with Mr. Mackinney as to the cost of electric lighting on different systems ; the statement I made is not new, and has never yet been demonstrated to be incorrect. It will interest me to know of established facts to the contrary. I quite agree with Mr. Campbell as to the haphazard methods of illumination existing in many printing establishments.

* *Illum. Eng.*, Lond., vol. iv., 1911, p. 213.

Mr. Leon Gaster, as usual, comes direct to the point. With sources of gas or electric light within reach of the operative, one frequently finds each man has made an adjustment to suit himself by producing the incorrect conditions he cites. With indirect lighting, especially with arc lamps, it is difficult, if not impossible, to act in this manner. Mr. Dow's suggestion of sharpening shadows by having a small source of light is interesting, but in direct contradiction of the opinion of Mr. Mascord, who, as a practical expert, definitely states from a long and wide experience that well-diffused lighting is more satisfactory than local lighting of a more concentrated character.

Direct reflection from the type face, especially when it is new, and if the lamps are not properly placed and carefully maintained in their correct positions, is most distressing. The trouble, however, is cured by indirect lighting, as no direct rays fall on the type, and consequently there is no direct reflection.

I quite agree with Mr. Dow as to the unsuitability of the two examples he mentions, and would like to call attention to the illustration of a composing room on p. 188 and a stereo foundry on p. 190 of *The Illuminating Engineer* of April, 1912, in both of which the faults he rightly deprecates will not be found.

Some Publications Received.*

Building in London. By Horace Cubitt, A.R.I.B.A.—A comprehensive treatise on the Law and Practice affecting the erection of Buildings in the Metropolis.

'*The Electrician*' *Wireman's Pocket Book.*—A new and revised edition of this book recently published, containing a large amount of information in very concise form, together with valuable tables.

The London Chamber of Commerce, Annual Report of Council.

Electric Power in the Printing Office. By Howard Marryat, M.I.E.E.—Reprinted from *The Electrician.*

Journal of the Franklin Institute.—The issue for April contains a paper by E. L. Nichols on 'Daylight,' presented at a recent meeting of the Institute.

The Physical Review.—The issue for March contains a short paper by F. C. Brown on 'The Effective Depth of Penetration of Selenium by Light.'

Among other publications we have also to acknowledge the receipt of the following: *Journal of the Royal Society of Arts, Journal of the Röntgen Society, Annales Scientifiques de l'Université de Jassy, Proceedings of the American Institute of Electrical Engineers, Proceedings of the American Academy of Arts and Sciences, Transactions of the South African Institute of Electrical Engineers, Zeitschrift für Wissentschaftliche Photographie Photophysik und Photochemie.*

* To some of these we hope to refer in greater detail shortly.

Private House Lighting.

(Abstract of Proceedings at a Meeting of the Illuminating Engineering Society, held in the House of the Royal Society of Arts (London), on Tuesday, April 16th, 1912.)

A MEETING of the Society was held on April 16th, 1912, Mr. F. W. Goodenough (Chairman of Council) being in the chair.

The minutes of the last meeting having been taken as read, the Chairman called upon the Hon. Secretary to read again the names of applicants for membership presented at the previous meeting, who were then formally declared members of the Society. The names of applicants for membership received since the last meeting were also read out for the first time.

The Chairman then called upon Mr. W. R. Rawlings to read his paper on 'Private House Lighting by Electricity.' This was followed by a paper by Mr. W. H. Y. Webber on 'Private House Lighting by Gas.' (These papers will be found *in extenso* on pp. 236-258.

The Chairman, in declaring the subject open for discussion, referred to the human element which was in evidence in both the papers, and which was always to be borne in mind when the lighting of our homes was under consideration. An interesting discussion then ensued, in which Mr. J. Darch, Mr. A. P. Trotter, Mr. J. G. Clark, Mr. V. H. Mackinney, Mr. Lovinson, Mr. Haydn T. Harrison, Prof. J. T. Morris, and Mr. L. Gaster took part, and the authors briefly replied to the remarks of the various speakers.

In conclusion, the Chairman proposed a very hearty vote of thanks to Mr. Webber and Mr. Rawlings for the papers, and announced that the annual meeting would take place at 8 P.M. on May 14th.

New Members of the Society.

The names of the applicants for membership read out at the previous meeting of the Society on March 19th were now read out for the second time, and these gentlemen were formally declared members of the Society.*

In addition, the names of the following gentlemen have been duly submitted to the Council, and were read out for the first time on April 16th :—

Barlow, H. D.	Electrical Contracting Engineer, Albion House, 61, New Oxford Street, London, W.C.
Buckle, C.	Fire Insurance Official, "Sunset," Meopham, Kent.
Johnstone, J. W.	Paper Manufacturer, St. Ann's, Hendon, London, N.W.
Matthews, R. L.	Manager of the Linolite Co., 25, Victoria Street, London, S.W.

* *Illum. Eng.*, Lond., April, 1912, p. 170.

Official Notice of Annual General Meeting.

As announced at the last Meeting, the **Annual General Meeting** will take place at the House of the Royal Society of Arts (John Street, Adelphi, London, W.C.) on **Tuesday, May 14th,** at 8 P.M, when the Report of the Council for the past session will be presented.

It is hoped that all members will make a special effort to be present.

Private House Lighting by Electricity.

By W. R. Rawlings.

(Paper presented at a meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts, John Street, Adelphi, London, W.C., on Tuesday, April 16th, at 8 P.M.)

The subject of this paper is one that appeals not only to those who are concerned in the applications of electric lighting, but to the public at large, both rich and poor. For civilization has made light an absolute necessity of life. Mankind no longer goes to bed with the setting sun. House lighting

Fig. 1.—Boudoir with candle fitting; small candle-power lamps without shades.

has evolved through various stages and by different mediums, but I shall confine this paper to 'Lighting by Electricity,' as I understand that Mr. W. H. Y. Webber is to read a corresponding paper on 'Private House Lighting by Gas.'

Dwelling-houses may be roughly divided into three types, viz. (1) the cottage, or artisan's dwelling; (2) the middle class house; and (3) the mansion, both town and country.

The first type, viz., the cottage, being the humblest of the three, has, until recent years, been somewhat neglected as far as electric lighting is concerned, but it is now generally agreed that it offers a promising field for enterprise. The first question is—What installation can be given for the usually limited amount of money available? Moreover, as there is seldom any margin for decorative effect, the illumination is perforce limited to one lamp in each room, fixed at the most useful height near to the centre or beside the window, and with an inexpensive shade to diffuse the light over the room. Apart, therefore, from the fact that it applies to such a large section of the population, there is little to interest the illuminating engineer in this class.

Coming next to the middle class house, we find that, while there is, of course, much more demand for increased illumination and decorative effect, there are naturally limitations as to expenditure. I will, therefore, at once pass on to the subject of the electric lighting of town and country mansions as offering the best examples and opportunities of the highest developments of artistic illumination, and as being a field in which I think I may claim some experience.

Mr. John Darch, in his valuable paper read before the British Institute of Architects, and also in his recent article in *Country Life* (which I would advise all the members of this Society to read), calls attention to the inadequate lighting of the home, and rightly so; but this is due not so much to the fault of the engineers as to other causes, to which I shall refer.

FIG. 2.—Lighting of staircase; alternate lights on 2-way switch all lights well screened.

The problem of the illumination of such a house is entirely different from that of an institution, club, or hotel. From the various discussions which have been taking place in this Society and elsewhere, it might perhaps be supposed that the production of artificial day light is the ideal illumination; but even if such light could be obtained at a low price, it is, in my opinion, unsuitable for the home, and should be confined to certain special applications, in cases in which the correct matching of colour, &c., is an all-important item.

Mankind craves for variety. When the sun has set, one desires, as a continuation of the light of the departing day, the warm tone which the artificial illuminants of to-day naturally provide. From this standpoint the old carbon filament lamp, with its yellow rays, gives greater satisfaction and a more pleasing effect than the white light of the metal filament lamp.

FIG. 3.—Light of large hall. showing crystal fittings. Standards used for local illumination.

Moreover, it may be pointed out that the only result of experiments on "artificial daylight" has been to produce a light which resembles daylight so far as the *colours* are concerned.

Fig. 5.—Music room, showing general illumination with special lighting for organ.

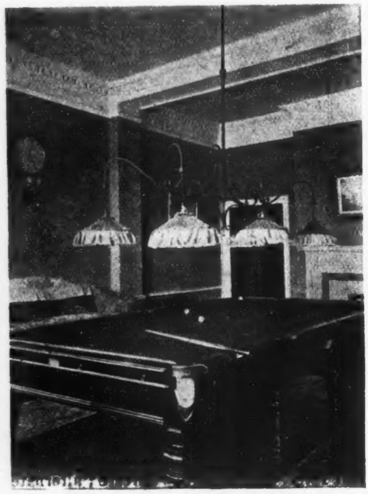


Fig. 4.—Lighting of billiard room.

But, as in the case of all artificial illuminants, the light emanates from a small point. Two square inches of surface would be a large radiating surface, and, even when diffusers are employed, 2 to 4 square feet would be about the limit found in practice. With daylight, however, the area of source of light is far greater than that of the objects to be illuminated and, even if the light has to pass through a window, the illuminating area is very large compared with artificial sources.

After all, it is not, in my opinion, a question whether a similar light to the sun's rays would be desirable, even if a perfect reproduction could be obtained, for it is found, in spite of its limitations, that the majority of people enjoy life as much under artificial illumination as they do under the rays of the "Giver of all light."

It may be argued that the important point to consider is not *what one likes,* but what one should use to illuminate the home properly. To this I would reply that people, as a rule, live according to their desires, whether these comply with the proper hygienic conditions of life or not, and by these desires

Fig. 6.—Lighting of corridor 2-way switch fitted to one light; the other for special lighting only.

the electrical contractor must necessarily be guided.

In some cases, for example, it is found that people do not object to glare. subject, so to arrange matters as to give the right and proper conditions of illumination, and yet to meet the consumer's wishes.

FIG. 7.—View of an interesting old mansion in Rutlandshire.

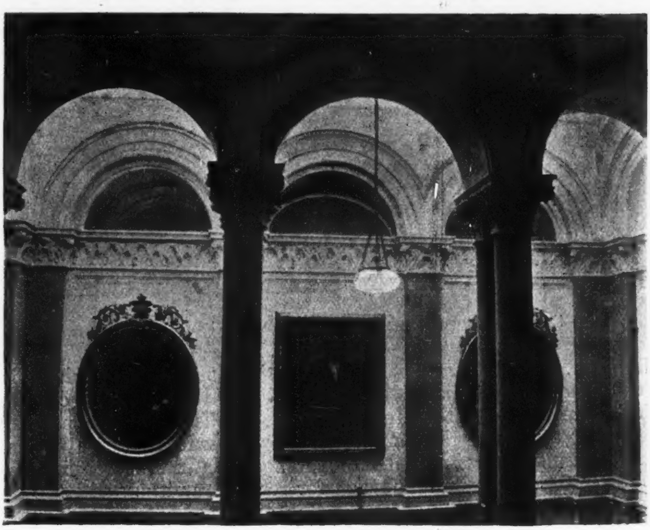


FIG. 8.—View of the hall, showing cut glass fitting.

It is the duty of the illuminating engineer to co-operate with the medical profession in teaching these people what is best for their wellbeing, and, with their skill and knowledge of the

What is the proper amount of light required ? Text-books and articles on illumination are to be found answering this question, giving schedules in foot-candles for different parts of the house,

such as bedrooms, dining-rooms, drawing-rooms, &c. In my opinion the art of illumination in the home is not to illuminate any room equally all over, but to produce the proper light and shade effect, according to the purpose for which it is intended.

There is no difficulty in providing a certain number of foot-candles for this or that purpose; the problem of house illumination is not so much one of foot-candles, as of convenience, taste, and personal requirements.

I am quite prepared to admit that there is a minimum limit in foot-candles for specific work. For instance, a bedroom is comfortably illuminated with a variation from ·2 to 1 foot-candle, but the dressing table and the part in front of the dressing mirrors must have at least 6 to 10 foot-candles on the dressing table surface; but this amount of illumination must be confined to these special positions.

A dining table requires not less than 2·5 foot-candles, and need not exceed 3·5; but the ceiling and walls of that room should be kept from ·5 to 1 foot-candle, so that the surroundings may be subdued in comparison with the table, and for this reason I do not advocate here indirect illumination.

Mr. Justus Eck, in a valuable paper on 'Indirect Lighting,' pointed out that animal life desired shade, and this he illustrated by many interesting slides, showing that both man and animals, when exposed to the direct rays of the sun, invariably sought shelter beneath the shade of a tree or building. This, of course, is what most of us would do. Even on a day when the sun is not shining, it is always pleasant to sit beneath the shelter of a tree. In like manner most people seek the similar shelter which is to be found in the alcove, conservatory, and the shade of the palm, and it is only when the actual illumination for specific work is required, such as for reading, writing, and the illumination of special objects, that the brighter light is desired. The billiard table, perhaps, provides as good an example as any of this contrast effect. It is well known that while the player likes a strong light on the table, he prefers a lower illumination for the rest of the room. It might, perhaps, have been thought that to illuminate the billiard

FIG. 9.—View of the hall landing showing Georgian fitting.

table properly a volume of light, such as that given by a skylight, would have been desirable; but, as a matter of fact, professionals prefer the method of local illumination. It is true that I have known cases where the table has been lighted from the cornice of the skylight, but this was not for a professional player, and, so far as I can learn, it would not comply with the professional requirements.

(3) The position of the light should be so placed as to illuminate specific objects (according to the nature and purpose of the room).

(4) That small units of light are in general to be preferred.

(5) Indirect lighting should only be used for general lighting, or as supplementary to the necessary local illumination.

I do not propose to enter into the

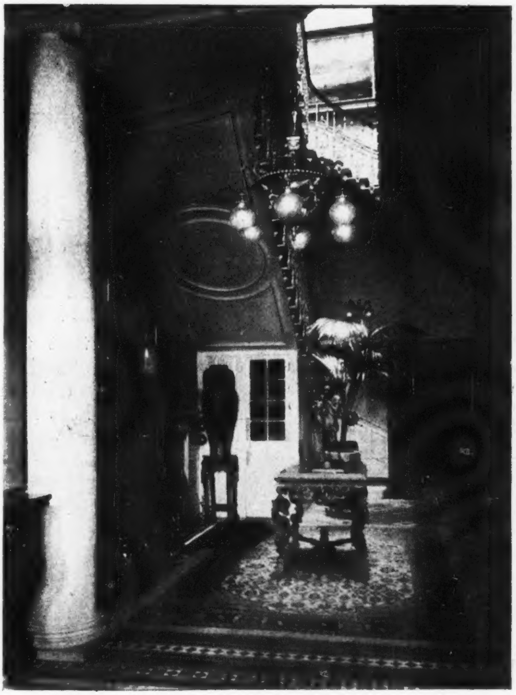


FIG. 10.—Lighting of Hall

I know of nothing more uncomfortable than a room equally illuminated on every square foot of the floor, and a room so lighted is, in my opinion, inartistic.

I suggest the following rules for illuminating the home:—

(1) That a room should not be evenly illuminated.

(2) The filament of the lamp should be so placed as not to be in the line of vision under normal conditions.

questions of the dimensions and positions of windows, the colours of papers, paints, or ceilings, &c., as these are items which do not as yet strictly fall within the scope of the contractor dealing with the artificial illumination of the house. The house is at present arranged with its windows, its style of decoration, and colour-treatment to suit the individual taste of the architect or owner; but the time is coming when the illuminating engineer

will also be a party to the arrangement of windows and the selection of the colour scheme. At the present time this phase of the art is frequently settled without his experience being consulted. The engineer is set the task of illuminating the house as he finds it in the best manner possible. The problem frequently assumes the form, not "How best to illuminate the house," but "How the problem can be solved to the satisfaction of the employer and his friends," most of whom have opinions of their own; and, since they pay the piper, it is natural they should desire their ideas to be carried out.

FIG. 11.—Bedroom lighting. Switch for centre fitting at bed and at door Master switch to light up the whole house fixed near door.

It is a common experience to be met with the remark that "it is not fashionable now to use brackets"; or another will remark "that no one thinks of fitting pendants"; while a third insists upon having nothing but standards, each in turn raising objections to one or other of the three fixtures. It is, therefore, a matter of tact in obtaining more or less a compromise between what is considered correct and what the powers that be insist upon.

It is seldom that the engineer is allowed free scope in placing the lights as he in his opinion thinks best, and, in a word, it is more difficult to

FIG. 12.—Lighting of billiard room.

satisfy the taste of the owner than the actual requirements of the house.

Not only do opinions differ as to the

FIG. 13.—Lighting o. Library.

upon having a light of 20 to 30 foot-candles on the dressing table, while another complains that one-fourth that amount is too much, from which it will be readily seen that it is difficult in the case of private houses to specify the illumination in foot-candles even for a specific purpose.

Again, one has to take into consideration the positions of the windows and the general arrangement of the furniture. In many instances the old positions which were allocated to gas or oil, permanently fixed with a view of being within easy reach, must be retained. For the owner, having adapted himself to the general inconvenience of the arrangement, will insist upon the new lights being in the same position as the old. Many absurdities of lighting to-day are due to this and other causes which I have mentioned.

I may now mention a few points to be borne in mind in illuminating a mansion. The town house re-

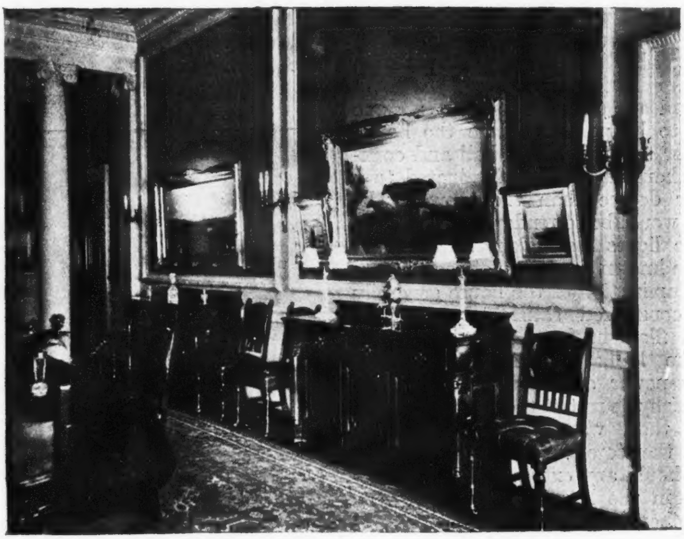


FIG. 14.—Showing special picture lighting in dining-room.

fittings, but there is a greater diversity with the individual as to the amount of light required. Some ladies insist

quires more light than the country house; the same people who consider a 16 c.-p. lamp too strong in the country

will complain that a 30 c.-p. lamp is insufficient when in town. This diversity is one of importance in all lighting problems, and, in my opinion, plays

FIG. 14.—Dining room showing glass bowl fittings and special picture lighting.

one of the most important parts in the illumination of houses. Excess of light in the town compels the same fault to be perpetrated in the home, and for this reason the hall and corridors should never be illuminated to a higher degree than the rooms. The effect would be to render the remainder of the lights insufficient by contrast. I have known a number of cases where the illumination of the house generally was considered satisfactory until a metal filament lamp had been fixed in the hall, doubling the original candle-power and causing dissatisfaction with the rest of the lighting (which until then was considered ample). It is, therefore, important that in no case should any excess of light be provided in the less important positions in the house, such as the corridors, &c.

I will now proceed to illustrate by a few slides some of the foregoing suggestions as to how the present-day house should be illuminated.

I regret that, unlike the slides exhibited at our last meeting, most of these have been taken in daylight, as it is difficult to obtain photos of private residences under conditions one would desire.

The slides do not exhibit a series of rooms illuminated as may be considered ideal from an illuminating engineer's point of view, but they are arranged with lights to harmonize with individual requirements and taste, and may be taken as typical examples.

Here are a few photos of middle class rooms :—

(1) Boudoir, fitted with exposed candle fittings, which are generally admired. As the lamps are of small candle-power there is very little glare, the centre fitting giving a general light, while brackets and standards provide for special lighting.

I will now ask you to take a walk over a country mansion in Hampshire, and I may mention that at this mansion practically everything is worked from the electrical generating plant, including the water supply, passenger lift, organ blowing, ventilation, part of the culinary heating and the lighting, burglar and fire alarms, telephones and bells, and water level and other indicators. The wiring is carried out on the

FIG. 15.—Drawing room showing lighting of pictures.

Kalkos tube system, the tube acting as the return negative conductor, one wire only being employed. In this mansion there are fitted also special switches to enable a light being turned on or off in all the corridors and hall at any time desired from a master switch.

FIG 16.—Use of Holophane shades in a study.

(2) The hall, foot of stairs, a seven-light Georgian fitting with obscured shades, giving as much illumination to the ceiling as the floor, providing a soft, diffused light. The writing table at the side has a special standard, not shown.

(3) Lounge is fitted with crystal Georgian fittings, the glass breaking up the direct vision of the lamps. This room is beautifully illuminated with a soft light, with a pleasant shade in the alcoves, special lights being provided for the writing table, &c.

(4) Billiard room. This fitting complies with the usual players' requirements, and also meets with the idea of the ladies as to artistic shade effect. These shades are of cardboard and covered with silk, each fitted with a 100 c.-p. lamp, and I am told is a perfect playing light. The cloth is the usual dark green, and it is difficult to over-illuminate its surface for billiard players. The surface of the table has a maximum illumination of 40 foot-candles

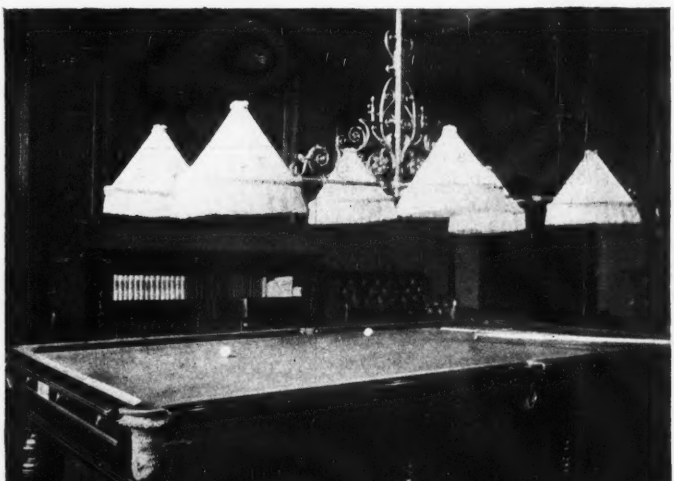


FIG. 17.—Lighting of billiard room, showing pink silk shades.

(5) Music - room. Fitted with Georgian crystal fittings, giving a good general diffused light. The organ is fitted with a series of lights to suit

FIG. 18.—Drawing room showing Louis XVI. shaded fittings.

personal taste, and, is automatically blown by an electric motor.

(6) We now ascend to the first floor, where one of the three-light fittings is shown. This fitting has one lamp which can be turned on or off at either end of the corridor, and this same lamp can be operated from the master switch, to be operated with others all over the corridors, halls, &c.

The next picture (Fig. 7) is a view of an interesting old mansion in Rutlandshire. The estate possesses the advantage of a splendid water supply, giving a constant energy equal to 10 h.p., which, by the application of a modern turbine, has been arranged to carry out all the pumping, lighting, and a large proportion of the heating and cooking, besides supplying current to a number of special electrical appliances, such as radiant baths, &c. It is interesting to note that the work was carried out after the decorators had renovated the building, and would have presented some difficulty had it not been for the Stannos system of wiring which was employed, the outer sheathing of which was used as the return conductor, thereby reducing the number of wires, and as a result the wiring is practically invisible.

In the early days the ideal position for the source of the lights was often sacrificed owing to the unsightliness of the wiring necessary to bring the current to the point required, but by the use of Metacase wires these difficulties have been overcome, and there is now no excuse for fittings being fixed other than in their proper positions.

Fig. 8 shows a view of the hall, where a cut glass fitting is seen forming one of a number which gives the general illumination, while Georgian brackets are used for wall lighting and standards for reading purposes.

Fig. 9 shows a view of the half landing and a Georgian fitting, which is not only decorative, but effective from the illuminating point of view.

Time will not permit, or I should like to have taken you over many of the interesting rooms of this mansion, so will pass on to the remainder of the slides.

I will now exhibit a few slides of rooms taken in a town mansion :—

FIG. 19.—Lighting of Hall.

(10) A very pretty hall, with well-screened shades. A picture is visible on the landing, to which I shall refer in the next slide.

(11) Bedroom lighting. Switch for centre fitting at bed and at door. Master switch to light up the whole house fixed near the door.

(13) Library, with screened Corona fitting with brackets on the wall. There are standards provided for special lighting.

(14) A corner in the dining-room, with Louis XVI. open light brackets. Note special picture lighting.

(14) Another view of the dining-room,

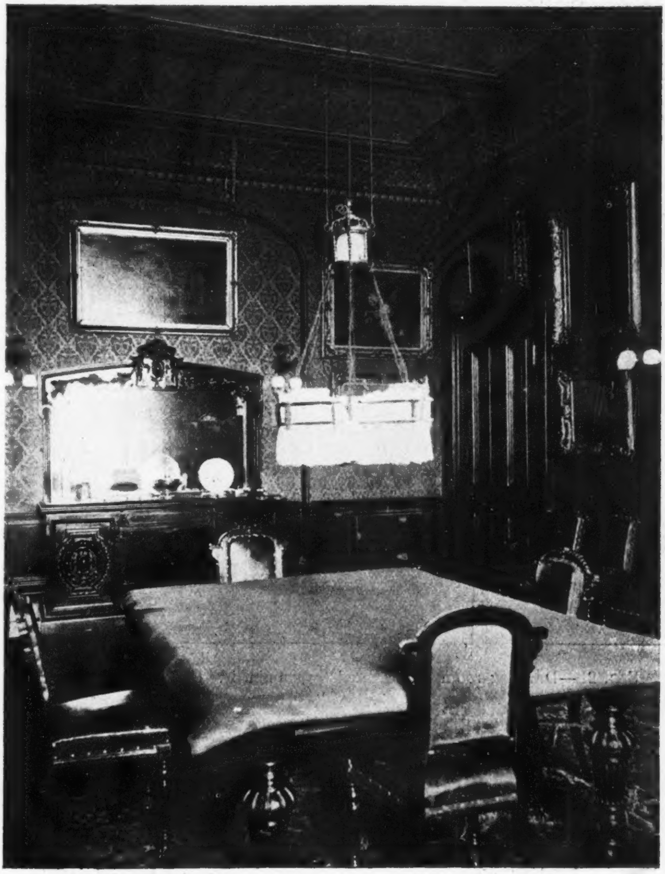


FIG. 20.—Dining room, showing corona silk flounce.

showing the glass bowl fittings in ceiling, which gives a general light to the room. Note picture lighting.

(12) Billiard room, with opal disc shades and silk valance, which is not only useful for lighting, but gives a most artistic effect. A three-light Louis XVI. bracket is seen on the wall, being one of a number fixed in this room.

(15) Drawing-room, illuminated by Louis XVI. brackets. A large number of the pictures are illuminated with

special reflectors. The wire carrying the picture is insulated and conveys the current.

I will now exhibit another series illustrating the lighting in another house :—

(16) Study, with Holophane shades, standards on side table for reading.

(17) Billiard room. Table illuminated by artificial lighting.

(18) Drawing-room, illuminated with shades, Louis XVI. fittings.

(19) Here is a view at the foot of stairs in a town house, where a lantern is surrounded by four lamps on a separate circuit, which is used for special lighting.

(20) A view in the dining-room, with a Corona fitting for table lights, and the small lantern above, which is screened by tortoiseshell, gives a pretty effect. Brackets are also used for general lighting.

(21) Views in the drawing-room. This room is illuminated by standards with shades over the lamps, and I consider this one of the most effectively and artistically illuminated rooms I know. The fittings and furniture are works of art, which doubtless adds to its charm. The three top lights are only used for dances, &c.

(22) A study with Louis XVI. fittings, all the lamps being well screened. Table standards are arranged for reading.

A number of additional slides showing typical styles of lighting in halls, sitting rooms, billiard rooms, &c., were also shown at the meeting by Mr. Rawlings.

The photos were taken by my assistant, Mr. Kelly, who also made the slides for this paper, and I wish to express my appreciation of his assistance. I am also indebted to the courtesy of Holophane Ltd., for the use of the Holophane Lumeter instrument in making measurements of illumination.

In this paper I have tried to explain some of the principles of private house lighting and some of the difficulties experienced in reconciling the requirements of good illumination with the tastes of the consumer. It may be hoped that the influence of this Society will gradually make itself felt by the general public, so that a better appre-

FIG. 21.—Drawing room, illuminated by standards. Ceiling lights for special occasions.

ciation of the nature of good illumination will be brought about.

Such a change on the part of the public may take time. But, by stimulating discussion on these matters, the Society will be directly beneficial in another way. The nature of good illumination in the home, the advantages of various styles of lighting, and the mistakes to be avoided, will become more fully understood, and the contractor who has studied these matters will be in a much better position to put his views forward. For having definite knowledge at his disposal, he will be able to explain to consumers *why* a certain course desired is not advisable, and he will have behind him the conclusions of the Illuminating Engineering Society in doing so. Having confidence that his contentions are correct, he will be able to advise consumers much more effectually, and to induce them more readily to accept his view. In this way we may hope to avoid many mistakes which ultimately create dissatisfaction, and of which the contractor not infrequently bears the blame. There are many points in private house lighting which remain to be discussed and settled, and the Society, by promoting mutual education in these matters, should help to raise the status of the contractor and enable him to assume a more independent position.

FIG. 22.—Lighting of study.

The Cost of Lighting.

THE writer of the 'Engineering Notes' in *The Daily Telegraph* not long ago pointed out the difficulty of the average consumer in reconciling the conflicting figures regarding gas and electric lighting by which he is so industriously bombarded.

In conclusion, he propounded a solution of the difficulties :—

"Let us have the matter investigated. Let the electrical and gas companies of London each appoint an engineer on their behalf for testing purposes. An independent engineer would also need to be appointed to check their figures and tests. That would settle once and for all this complex matter of costs. It is perfectly clear that if one of the parties will not agree to that method of solution, they should provide a very good reason for their refusal."

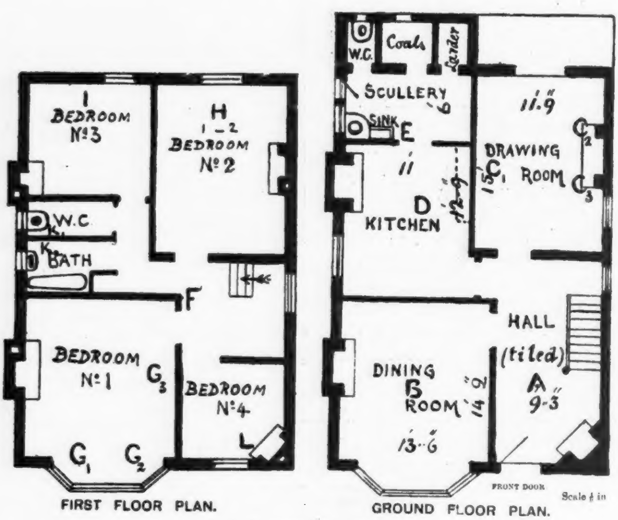
Whatever may be thought of the merits of this suggestion, it at least serves to illustrate the general recognition that an impartial expert is needed. Meantime, where is he to be found ? The ideal illuminating engineer, as has been often pointed out in these columns, can only be evolved *gradually* by a systematic course of education. This evolution, it may be hoped, the Illuminating Engineering Society will ultimately be the means of bringing about.

Private House Lighting by Gas.

By W. H. Y. Webber.

(Paper read at a meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts, John Street, Adelphi, London, W.C., on Tuesday, April 16th, at 8 P.M.)

The subject upon which I have been requested to speak this evening is scarcely one that would be chosen by an advocate of any kind of artificial lighting who wished to draw a dazzling picture of the capabilities of his particular illuminant. The very title of my paper suggests a *milieu* in which sensational effects of all kinds are out of place. In the home all things are, or should be, subdued and homely. The ideas suggested are those of a cheerful fireside, with book and pipe, a friendly rubber, or a social meal.



Explanatory Notes.

A.	Hall Lantern,	Medium size	Inverted,	$2\frac{1}{2}$ cu. ft. per hour,	electric ignition.
B.	Dining Room	Ditto			hand ignition.
D.	Kitchen	Full	,, ,,	$3\frac{1}{2}$—4 ,,	,, ,, ,,
C.	Drawing Room	"Bijou"	,,	1 ,,	, ,, ,,
E.	Scullery	Flat-flame		5 ,,	,, ,, ,,
F.	Landing	,, ,,		5 ,,	(Breeden's Pilot) ,,
K.	Bath and W.C.	,,		5 ,,	,, ,, ,,
G. H. I. L.	Bedrooms	"Bijou"	Inverted	1 ,, ea.	Electric, pneumatic or hand ignition.

Fig. 1.—Gas Lighting Plan for a Small House.

In these circumstances figures regarding foot-candles, zonal distribution, or the initial intensity, &c., are often out of place. There are other aspects in which one would prefer to regard our home light.

Let me, however, summon up my scientific mood, and survey the lighted home with the coldly appraising eye of a bailiff with his note-book ready for the inevitable inventory. The first observation I would make is that the truth of the saying about "the appetite growing with what it feeds on" has been corroborated by the progress of private house lighting. It is not my duty to lead you into the darkened rooms of the distant past of pine torch and dim taper, but a passing glance serves to show that increased efficiency has been almost invariably at the sacrifice of picturesqueness. We may pride ourselves upon our artistic imitations of candles (with a brilliancy that no wax ever produced), but we cannot rival the magnificent tableau presented by the hall of the house of Menteith, when, as chronicled in 'A Legend of Montrose,' "the large oaken table was spread with substantial joints of meat, and seats were placed in order for the guests. Behind every seat stood a gigantic Highlander, completely dressed and armed after the fashion of his country, holding in his right hand his drawn sword with the point turned downwards, and in the left a blazing torch made of bog-pine."

FIG. 2.

I think we have lost something in our pursuit of high-temperature light besides picturesqueness. We are all for the piccolo nowadays, and have forgotten the 'cello. We hardly ever talk of the tone of an artificial light, except to find fault with it for being different from sunlight. Apart from certain technical and commercial purposes, is this altogether wise? Must we bid farewell to the soft *chiaroscuro* of so many happy memories, and dwell for ever in a restless, if not glaring north light?

I remember well the country home of my childhood, and the evenings spent in preparing lessons by the modest glimmer of one or, as a luxury, a couple of "composite" candles, with somebody else placidly, but not unwatchfully, sewing on the opposite side of the table. Reading, away from the immediate vicinity of the candles, was an impossibility; and remembrance of this style of lighting lends point to the advice of the old physician to his ageing patient "not to attempt to read anything after dinner smaller than the nine of clubs."

The substitution of gas light for candles, used on the scale appropriate for frugal households, and not with the lordly lavishness associated with the glass candelabra of gilded saloons, marked an era of the advance of the middle class of townspeople in comfortable living. Gas was always a middle-class luxury. It never invaded the marble halls of the West End; and, of course, the poor could not get it. It was admitted to the rich man's kitchens and domestic offices, and its attractions beckoned the work-

ing man to his only club, the corner pub. As a domestic light in the fullest sense of the word, it was almost as sure a sign of respectability as the keeping of a gig. For many years the accepted standard of serviceable indoor lighting was set by the average brightness of a good flat-flame gas burner, consuming anything from 5 to 8 cubic feet an hour. That is, a "gas light" was popularly understood to mean such a unit, the luminous intensity of which would be about 15 c.-p. at the most. With the inferior burners in common use, 5 cubic feet of gas per hour might give as little as 7 or 8 candle-light, which was getting perilously near the complaint line of "bad gas." Of course, the gas companies of those days had nothing to do with the performance of the consumers' burners. A wise legislature fixed the "quality" or illuminating power of the gas at a figure referring to the efficiency in scrupulous hands and under test conditions of the best burner procurable for developing the luminosity of the gas flame, subject only to the qualification that it must be capable of being used by the consumer. That condition was fulfilled; but no power could make the consumer use such a burner in the ordinary way, and accordingly, as a matter of fact, he did with something much inferior and cheaper.

The ordinary flat-flame gas light was about as powerful as a good "moderator" or "paraffin" lamp of the period. It therefore suffered nothing as a lighting unit by comparison with these other lights, the only available change from candles. It is a pretty good moderator or other Argand lamp for heavy oil, or single-wick mineral oil lamp, which will give more than the amount of light named — 15 c.-p. On the average, gas lights were brighter, as well as giving no trouble and being safer. A well-lit "parlour" or dining-room 13 ft. or 14 ft. square would usually have a centre three- or perhaps a five-light heavy brazen pendant, with balance-weights and hydraulic seal, which was regarded as a fitting that no respectable sitting-room should be without. There would be others on the same principle, but of different

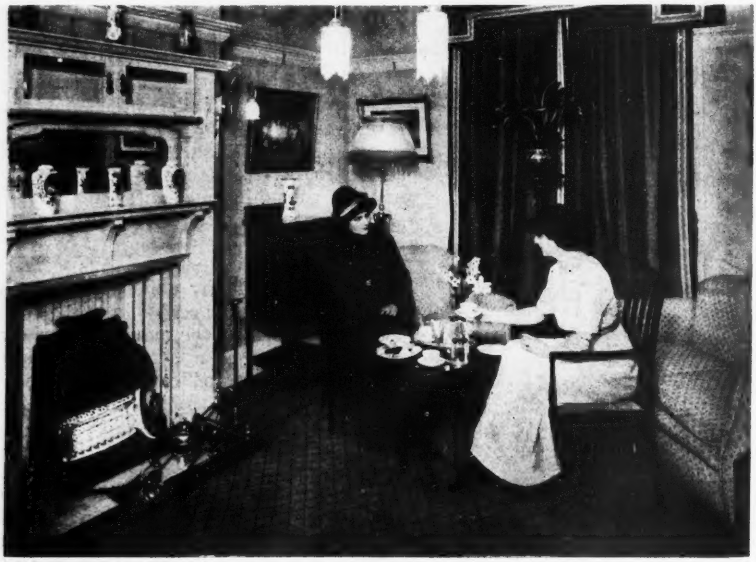


FIG. 3.

pattern, in the drawing-room and the breakfast-room. A T-pendant for two lights would be in the kitchen, if large, or a single "cork-slide" pendant if the apartment were small. A "harp pendant" in the entrance hall and wall brackets in the upstair rooms would exhaust the variety of fittings—all, of course, carrying the same lights.

It strikes us as a little odd nowadays that the light of these simple flat-flame gas burners, even without shades, should ever have deserved the opprobrious epithet "garish," freely applied to it by persons of taste. Yet as all things are relative, no doubt the sparse employment even of such units, not well placed for the avoidance of glare, was irritating to eyes accustomed to the soft illumination of well-shaded oil lamps. In fact, the use of shades was far more general with the better class of colza oil lamps than it was with gas before the late William Sugg, whose taste was distinctly Parisian, taught Londoners the proper use of flat-flame governed burners with his so-called "Christiania" shades, which constituted the most scientific and pleasing system of gas lighting known then or since—for all our approved modern practice of indoor lighting derives from this. The thing is now, of course, past praying for, but I for one am old-fashioned enough to hold the opinion that for prolonged reading in the seclusion of a library or in the study the mellow light of a good Argand gas lamp, suitably shaded, is still the most comfortable and innocuous of all means of localized illumination.

FIG. 4.

We must, however, move with the times, and lay our account with the vastly more economical and effective light of the incandescent Welsbach mantle. It remains to apply this illuminant to our purposes, including the lighting of our homes. It would be foreign to my present subject to detail the steps and stages through which this method of obtaining light from gas has passed, even for domestic applications. Suffice it to say that its progress has lain along the two main types of upright and inverted mantle burners, and also that for both the application of distance and quasi-automatic ignition has proceeded to

lengths of convenience and safety unattempted in regard to luminous flame lights. The fundamental advantage of the incandescent mantle system of indoor gas lighting lies in the fact that, speaking practically, it has abolished the old convention of "quality" in respect of the illuminating value of town gas. It is the burner and the mantle that count in the production of gas light. The immediate result of the change of base is seen in the superiority of the lighting appliances actually used by consumers, even the poorest, to the still statutory test burner. For whereas, under the old dispensation, with the test burner prescribed as already mentioned, the public generally did not get nearly as much light from the gas they paid for as was possible, now they can suit themselves quite conveniently and cheaply with lamps yielding tenfold the quantity of light officially accredited to the same gas. And this superiority is equally shown by all and any size lamp they have occasion for.

Given, then, a reasonable degree of uniformity in the composition and pressure of the supply, there is no such thing as "bad gas." There are only differences of merit in burners and mantles, as in other market goods, and mostly for the same reason. You pay a higher price for a better article, and the careful user gets more for his money than the heedless man.

I would here interpose the observation that the flat-flame gas light is by no means obsolete, or even obsolescent. It is the town's safety light, to be trusted to keep watch over all byways, tunnels, exits, stairways, corridors, stables, and cellars. Once lit, always burning so long as needed without any attention. In short, it is indicated for all purposes, and they are many, where illumination is less in question than the showing of a light. The rule of Capt. Shaw of the Metropolitan Fire Brigade is in point in this connexion: "On an alarm of fire, turn up all lights." There is a useful fitting for such applications of long standing, though not so well known as it should be. I shall have occasion to mention it again in connexion with the fitting-up of a house. It is called "Breeden's pilot," and consists of a simple push button to reduce the flame to a glimmer with a touch. This is better than trusting to the lowering of the gas by means of the burner cock, which might put out the light altogether with fumbling handling.

FIG. 5.

Flat-flame burners are low-pressure burners, requiring not more than seven-tenths of an inch of water-gauge pressure. As gas main pressures nowadays run much higher than this, it is expedient to regulate such flames by putting a so-called "economiser" tip, say, No. 7, upon a "regulator" burner of a smaller size, say, a No. 3, where the gas pressure is as high as forty-tenths. This arrangement wire-draws

the gas down to the proper pressure for the flame. The higher the supply pressure, the greater should be the difference between the two numbers, and vice versâ. This preserves the form of the flame and saves gas.

Incandescent mantle burners of all types are comparatively high-pressure appliances. Not that there is any measurable pressure inside the mantle, even in what is called high or increased pressure lights; but the gas pressure is converted in the Bunsen burner into velocity of flow, which is expended in entraining the primary air into the Bunsen tube. Ordinary indoor incandescent burners are most efficient under an acting gas pressure at the nipple of about twenty-tenths, and should always be governed or regulated to this by a suitable appliance independent of the burner cock. All burners should be so adjusted to work with the burner cock *turned full on.* This is essential. No such burner can be properly and reliably regulated by the burner cock, because if this is partly turned off to check the consumption of gas, the pressure at the nipple is also affected, and the Bunsen will not function properly.

FIG. 6.

Having cleared up these preliminary points relating to the correct control of the burners, we can now proceed to deal with the ordinary problem of planning a scheme of gas lighting for a typical suburban middle-class residence, such as would command a rent of £40 a year; and is being built all round London by thousands every year. The arrangement of this is shown in tabular form in Fig. 1.

First, as to the entrance hall and front door lighting. The conditions necessary to be observed are that the light shall fall on the face of any one approaching the door after dark, while coming from well overhead and behind the person answering the door. If there is a flight of outside steps and a deep porch, it might be advisable to have a light projecting from the fanlight, but with an approach on the level the disposition shown will suffice. It calls for a medium power inverted lamp, clear underneath, in a not too "arty" lantern, which can be, if preferred, controlled by a switch in the wall. This will also light the doorways to the lower apartments and the lower flight of stairs.

For the dining-room the light must, of course, be concentrated upon the table. Its power will depend upon the size of the apartment and its shape, but it should not be less than 60 c.-p. An adjustable pendant is indicated, which, when lowered, will provide ample light for reading by the fireside. It may be stipulated here that old-fashioned gas fittings for flat-flame burners, including especially the "water-slide" pendant accepted unquestioningly by the past generation, are quite unsuitable for incandescent

burners. The increase of gas pressure has rendered the latter dangerous. It can be converted, but is rarely worth it. Modern gas fittings are lighter and steadier than the old patterns. If preferred, a pair of smaller lights can be added beside the fireplace.

For the drawing-room scattered small units are best. These can be either bracket lights, or dropped as short, stiff pendants from the ceiling. A wall-light in the garden verandah is appreciated in summer-time, nor is it impracticable to extend the lighting into a shady nook of the garden.

FIG. 7.

In the kitchen adequate lighting is necessary. A single pendant high up, or a pair to afford cross-lighting of the kitchener, will be appreciated by the cook. The scullery and back door can be served by a single flat flame.

On the stair landing we want a watch-light as well as adequate illumination, and accordingly a flat flame, with Breeden's pilot for night use, is indicated. The same for the bathroom and w.c.

Pendants are most convenient for bedrooms, as permitting free arrangement of the big furniture. Dressing tables should have the light coming from overhead, as nearly as possible in the same way as daylight, and cross-lights are preferred. A bed light is a great comfort. Single units will suffice for the smaller rooms. With all lights full on—a rare occurrence—the total consumption of gas would be about 50 cubic feet per hour. Under the old conditions it would be more than double for the same number of points. The increased amount of light would be as 4 to 1. I have borrowed this scheme of strictly domestic gas lighting, as adapted to the homes of people who appreciate comfort but have to study expense, from the Staff Instruction Curriculum of the Gas Light and Coke Company. In Figs. 2—7 are shown a series of illustrations of rooms lighted in various ways kindly supplied by the South Metropolitan Gas Co., and Fig. 8 shows the lighting of a small billiard table (the Gas Light and Coke Company).

It is interesting to note that the ordinary lighting value of the modern unit is about treble that of the common

flat flame. This speaks eloquently of the heightened standard of indoor illumination which has come into vogue with the incandescent gas light. It could not have originated otherwise, seeing that, as already remarked, the colza oil and single-wick paraffin lamp does not give more than 15 c.-p.; and the contemporary domestic standard incandescent electric lamp was of 8 c.-p.

Pleasant household lighting is more a question of proper disposition of the lights than of mere candle-power, although the circumstance of having to allow in all cases a head-room of 6 ft. 6 in. from the floor is of itself a preventive of the bad placing of the lights too often seen in shop windows, with the naked illuminant in the line of sight. There can be no glare when the sources are well up out of the way. Although ordinary domestic lighting of middle-class dwellings does not permit of much range of fancy in the disposition of the sources, it offers plenty of scope in a modest way for the correct and tasteful choice of fittings and shades. There is seldom use for the more powerful units. If it is a sound rule, as I hold, that the power of the units of artificial light should be governed by the scale of the enclosed space to be lighted, then it follows that in the ordinary £40 a year house nothing more powerful than a medium size inverted incandescent gas lamp, burning about 2½ cubic feet of gas an hour, and shedding a luminous intensity of between 50 and 60 c.-p. in the lower hemispherical zone, is likely to be called for in any apartment. And only then if, as in the dining-room, a brilliant downward illumination is required. This paper is, as a matter of fact, being written by the light of such a source, which is ample for a cosy room about 13 ft. square, not counting window or sideboard recesses, although the walls are covered with dark brown paper and the furniture is black oak. The ceiling and a deep frieze are white, which is a wonderful aid to light diffusion. When the white table cloth is spread, the brilliancy is quite enough for any one. It is only in this connection that I consider it pertinent to speak of calculated illumination of surfaces; and I take it tnat for purposes of reading, writing, or needlework it is necessary to have at cemmand a lighting value of 3 to 4 foot-candles, which can be obtained quite easily and simply by the means here described, without suspicion of glare, by choosing a suitably shaded globe, open or clear underneath. (*Mem.*—I always recommend my women folk to spread a white cloth under any "black work" they may have to do at night.)

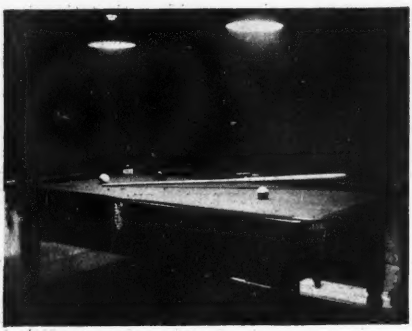


FIG. 8.—Perfect Lighting of a small Billiard Table. Two "Bijou" Burners (G. L. & C. Co.).

Personally, I am no lover of indirect lighting by diffused reflection from a white ceiling, although I have secured a very pretty effect by suspending a Japanese umbrella under a ceiling lamp. I certainly do not admire the heavy, solid copper basin reflectors I have seen in use for a similar purpose. Complete opacity in the case of such reflectors is a mistake. To me, however, the shadowless lighting resulting from this treatment of home lights is unsettling to the nerves. I find myself drifting out of such a room to one where I can see the lamp if I want to. I believe that lamps, like other good servants, should be neither in the way nor out of the way.

One other form of light to which I object is the sham candle. I know it is a selling article, but that does not redeem it in my eyes. The real wax

candle is a beautiful thing, and good candle light is hard to beat. The colza moderator lamp, too, is elegant, which is more than can be said of most petroleum lamps. I do not admire the stiff, upright incandescent gas burner, while confessing its serviceability. The inverted incandescent lamp, however, with a well-chosen shade, can claim one's admiration of its form as well as our appreciation of its solid merits, and I am satisfied to leave it at that.

Finally, there is the matter of automatic ignition. I have nothing to add to what has been said here by Mr. A. E. Broadberry on distance igniters, several forms of which are quite as suitable for house as they are for shop lights.

[The discussion on the papers by Mr. Rawlings and Mr. Webber will be published in our next number.—Ed.]

Modern Methods of Shop-Window Lighting by Gas.

An interesting article on this subject by Mr. A. H. Johnston of the Oregon Power Co. (U.S.A.) was recently printed by *The Progressive Age*, being one of a series invited in the "Window Lighting Competition" organized by that journal.

Many of the remarks of the author are in striking agreement with the suggestions now made by lighting specialists in this country. "The real object of show-window lighting," he says, "is not to light up the window, but the display of goods; and in such a manner that attention will be attracted to the goods and not to the light. It should be only an afterthought in the mind of the spectator that the light is good if he notices it at all."

It ought not to be necessary to emphasize this point, but it is a fact that, although this conception of shop-window illumination is generally accepted by lighting experts of to-day, it has not yet been sufficiently brought home to the users of light. The difficulty is to induce consumers to discriminate between the principle of using light for illuminating the contents of the window and the idea of hanging up powerful lights as an advertisement.

The idea of elaborate display window lighting naturally appeals most to the well-to-do merchant. This variety of business has sometimes been looked upon as exclusively electrical; but Mr. Johnston contends that there is no reason why it should not be done equally effectively by gas if scientific methods of illumination are employed. Cost, however, only plays a very subordinate part in inducing merchants to adopt illuminated show-windows. It is the *effect* and the skill brought to bear on the choice and arrangement of the lights that tells.

The author considers that the simple upright burner is not adapted for display window lighting proper. Clusters of inverted burners equipped with appropriate reflectors are what is usually required. A favourite method is to arrange such lamps at the top and front of the window so as to throw their light downward and inward on the goods, while themselves invisible from the pavement.

What, however, is considered the most effective method of all is to arrange the lamps with concentrating reflectors in a separate chamber above a diffusing sheet of glass. They are then completely screened from the contents of the window, and there is no possibility of the products of combustion doing any harm. An enclosure of this kind can also be made safer as regards fire. The lamps should be controlled from outside the enclosure either by pneumatic, independent bypass, or electrical ignition methods. They can be attended to from above without disturbing the window in any way, and can readily be rearranged if need be. As a rule one aims at uniform distribution of illumination over the window. The diffusing glass screen is divided into a suitable number of panels provided with lamps spaced at the requisite intervals. But occasionally it may be desired to concentrate the illumination specially on some object of interest in the window, and this can

be done either by partially extinguishing some of the lights, or by altering their grouping. In this way the lighting can be adapted for the display of new goods to the best advantage when a rearrangement of the window is made. Above all the method has the advantage that the eyes of people in the street are completely screened from the direct rays of light. The sources of light are invisible, but a flood of light is thrown on the contents of the window. When the light is thus wisely applied and directed on the goods there need be little fear of undue brilliancy, and it is better to provide an excess of illumination than too little.

A Suggested National Testing Laboratory for the Gas Industry.

An interesting suggestion was made recently by Mr. R. J. Rogers of the Birmingham Gas Department, in his presidential address before the Midland Junior Gas Association. The establishment of a central testing laboratory would, he thought, be of great advantage to the gas industry, especially to some of the smaller undertakings.

The well-equipped laboratories which are already established in connexion with some of the largest gas companies in the country, he remarks, need not be interfered with in any way by the proposed central institution, which would be supplementary to these. It would be primarily for the benefit of the smaller undertakings, to whom reliable information regarding new apparatus, and independent tests carried out by a recognized authority, would be of considerable value. In view of the multiplicity of gas appliances for lighting, cooking, and heating which are now available, it is impossible for every local gas manager to make his own tests, and it would result in a saving of money and of much repetition work if a test certificate, issued by such a national testing laboratory as is proposed, were obtainable.

Artistic Show-Window Lighting.

Some Examples at the Women's Exhibition in Berlin.

By the courtesy of Messrs. Ehrich und Grätz we have received some illustrations of examples of gas-lighted show windows at the recent exhibition in Berlin entitled "Die Frau in Haus und Beruf," recently described in the *Journal für Gasbeleuchtung*. The exhibits themselves appear to have been of an exceptionally attractive kind, but—what from our standpoint is more interesting still—a special feature was made of the combined scheming out of artistic methods of decoration and lighting.

The exhibition, being arranged to illustrate women's work in the house and in business, dealt both with domestic matters and with such industries as shop window dressing, millinery,

restaurants, &c. In arranging these displays, the co-operation was sought of a number of well-known lady artists in Berlin, including Fräulein Lotte Klopsch, who arranged a series of demonstrations of domestic lighting, and Fräulein von Hahn, by whom the shop window displays were designed. The former is stated to have devised quite a number of fantastic new forms of decorative lighting units, and this incursion of women into the field of artistic illuminating engineering is a precedent which will be followed with great interest.

(Hefner). It is also stated that, although the Exhibition lasted for four weeks, no appreciable alteration could be seen in the materials, in spite of the intensity of the light. In the two windows seen on either side concealed lighting is also employed with very striking effect, the new 200 H.K. units being utilized above diffusing glass screens.

In Fig. 2 ceiling lighting with units of the same kind is mainly employed, the burners being completely screened from the eye by suitably coloured silk shades. The same general principle

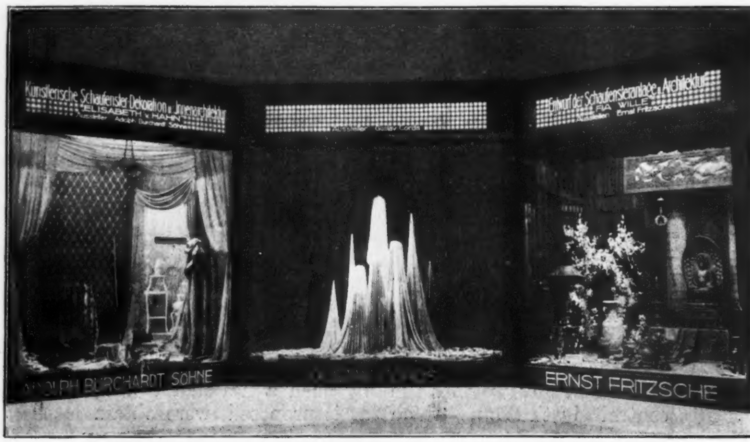


FIG 1.

The three figures (1, 2, and 3) are reproduced from photographs of tastefully lighted shop windows. The centre-window seen in Fig. 1 is particularly interesting, the pile of coloured fabrics being illuminated on the searchlight principle by a series of concealed incandescent gas lights, so as to stand out almost like a "fountain of light" against the dark background. The illumination is provided by six Grätzin 110 H.K. lights equipped with a new and special form of concentrating reflector, which, we are informed, gave an effective candle-power in the desired direction of as much as 65,000 candles

is used in the window reproduced in Fig. 3, where low-pressure 1,000 H.K. units are employed.

The Exhibition is stated to have been a great success, having been attended by nearly 400,000 people. Towards the end it became necessary to close the doors on several occasions to prevent over-crowding. To those in this country who are concerned in the problem of arranging attractive and novel displays with a view to kindling public interest in the uses of gas and electricity, this appears to present an object lesson from which something might be learned.

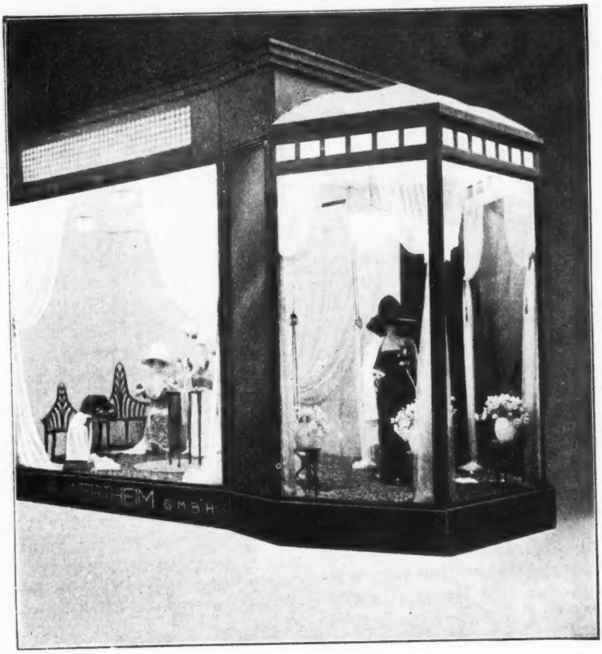


FIG. 2.

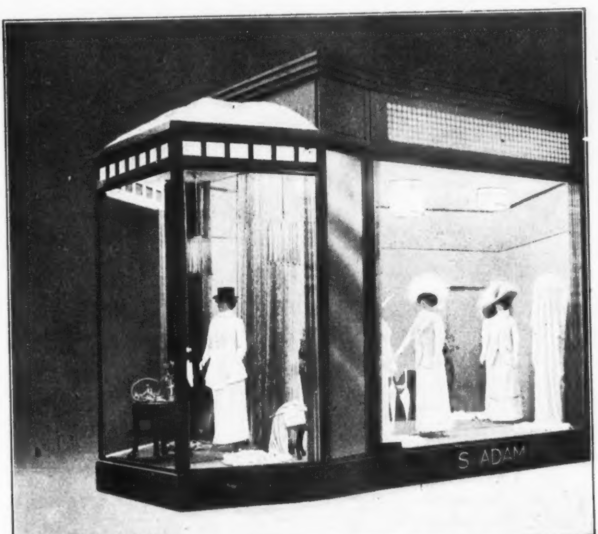


FIG. 3.

Illumination at the Smoke Abatement Exhibition.

THE Smoke Abatement Exhibition, which recently took place at the Agricultural Hall (March 23rd–April 4th), was primarily devoted to power, heating and cooking by smokeless means, but also contained some interesting examples of lighting.

The Electrical Section, organized by the Electric Supply Publicity Committee provided what was perhaps the most striking display from this standpoint. The passage leading to the hall was lighted by a series of white Excello arc lamps, and the entrance was indicated by a sign illuminated by mercury vapour lamps. The hall was decorated in hangings of a light tint, and this facilitated the use of indirect and semi-indirect methods of lighting on a somewhat unusual plan. As will be seen from Fig. 1, on the opposite page, the general illumination was provided by three rows of hanging units, respectively of the B.T.H. ("Eye-Rest"), the Adnil, and the General Electric Co. types, while the small tables of the Electrical Restaurant also received additional local light from table lamps equipped with silk and "spookie" shades.

Another view will be seen in Fig. 2, which shows an additional feature, namely, the use of Holophane satin finish residence reflectors and pines round the walls of the hall. The exhibition thus provided quite an unusual display of lighting by various novel methods, the combination of the different systems being distinctly effective. It may be added that illuminated signs and placards announcing the various displays of the use of electricity for heating, cooking, and laundry purposes were also largely used, an attractive feature of the whole display being the restful effect and absence of glare. These photographs, it may be mentioned, were taken, by kind permission, entirely by the artificial lights, the exposure being determined by the aid of the Holophane Lumeter.

In the remainder of the Exhibition a bright illumination was provided by high-pressure gas lights hung high up. One of the chief features was, of course, the joint exhibit of the Gas Light and Coke, South Metropolitan, Commercial, Brentford, and other gas companies, where demonstrations of the economical use of gas for heating houses, flats, shops, &c., for hot water supply, laundry work, and other purposes were given.

The greater part of the stands in the hall was naturally given up to various forms of gas stoves, boilers, furnaces, and other heating appliances, but there were several lighting exhibits, such as the "Dacolight" gas lamps.

We must also not forget to mention the Union Electric Co.'s display of the "Union" shop window lighting by concealed arc lamps, which, it will be recalled, was shown previously at a meeting of the Illuminating Engineering Society during this year.

The George Montefiore Triennial Prize.

WE have received particulars of the conditions affecting the award of the George Montefiore prize, which will next be presented in 1914. The prize was instituted by the President and Founder of the Fondation George Montefiore, Liège, and is presented, at intervals of three years, for the best original treatise on some scientific advance or technical application of electricity. It consists of the accumulated interest on 150,000 francs in the *rente belge*.

The final date for the reception of competing treatises is March 31st, 1914. Further particulars can be obtained from the Secretary of the Fondation George Montefiore, 31, Rue St. Gilles, Liège, Belgium.

FIG. 1.—General view showing Indirect and Semi-indirect Lighting Units in Electrical Restaurant.

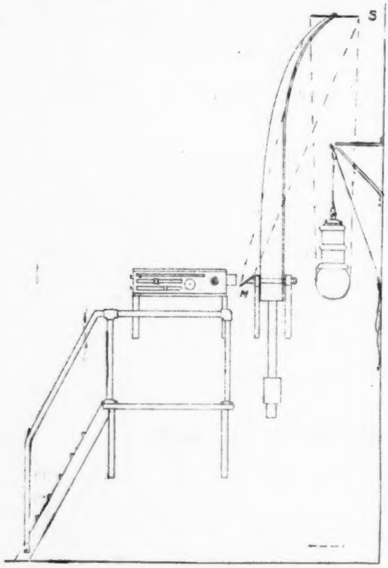
FIG. 2.—Another view showing Local Table Lighting and Holophane Reflectors and Pines used down the sides of the room.

Lighting of the Electrical Exhibit at the Smoke Abatement Exhibition.

CORRESPONDENCE.

New Methods of Obtaining Polar Curves of Light Distribution.

SIR,—The article in your issue for January, 1912, on 'New Apparatus for the Measurement of Light and Illumination,' by J. S. Dow and V. H. Mackinney, has interested me very much, inasmuch as the apparatus which the authors describe as a new device for obtaining polar curves of light distribution is identical in principle with one described by myself in my lecture on



'The Measurement of Light,' in the course of lectures on 'Illuminating Engineering' given at the Johns Hopkins University in 1910. The apparatus referred to is described and illustrated in pp. 471–3 of the first volume of the lectures. In the apparatus of this description which is installed at the Electrical Testing Laboratories, the length of the rotating arm is such that the distance between the lamp under measurement and the white test-plate is 10 ft. This distance has been selected in view of the general adoption of 10 ft. as the proper distance from a lamp with a reflector and the photometer disc. The values so obtained are designated as apparent candle-power values at 10 ft. The focussing effect and the considerable size of some of the reflectors with which lamps are equipped make it necessary to establish a standard distance of this sort, and this distance should be considerably greater than that which is shown on the polar curve apparatus described by Messrs. Dow and Mackinney. It is doubtful, therefore, whether the latter apparatus would be adapted to the determination of the polar curves of either very large reflectors or of those of the focussing type.

In an improved construction of the apparatus described in the Johns Hopkins lecture, the horizontal shaft which carries the rotating arm is hollow, and bears at its end nearest the lamp a mirror inclined at such an angle that, with the photometer placed at the opposite end of the opening in the shaft, the white test-plate is viewed directly. Contrary to the suggestions of Messrs. Dow and Mackinney, one of the principal difficulties of the apparatus has been to screen off stray light. While, theoretically, it may be possible to measure the stray light and to allow for it in the result, yet it is evident that this imposes very severe conditions on the photometric apparatus and upon the observer. If there is a stray light effect of only two or three per cent, it is clear that the photometric apparatus must have a very wide range in order to measure it. It is also true that the

stray light effect might in some cases be a considerable percentage of the total, as when measuring towards the socket of the lamp. It has seemed, therefore, that it is a practical necessity to use the apparatus in a dark room, and to equip it with very carefully arranged screens, so that stray light may be practically excluded from falling on the test-plate.

An advantage of this type of apparatus, which is not mentioned by Messrs. Dow and Mackinney, is that the size of the light source with which it may be used is practically not limited by the size of any mirrors in the apparatus. This, of course, is true of some other types of apparatus for obtaining polar curves, but they are not of the most convenient types, whereas the present apparatus is a very convenient one to employ, and enables work to be done very quickly.

The proposal of Messrs. Dow and Mackinney to attach a sheet of polar co-ordinate paper to the axis of the apparatus and to plot their readings thereon directly is very interesting, and is, apparently, quite novel. It is somewhat remarkable that, in view of the extreme simplicity of the principle involved in the polar curve apparatus and its manifest advantages, it has not been thought of and described years ago, but, so far as I know, my own publication was the first to be made of this form of apparatus.

Yours very truly,
CLAYTON H. SHARP.

SIR,—I am extremely interested to hear of Dr. Sharp's form of apparatus. It affords an instance of the amount of useful information embodied in the Johns Hopkins lectures, and not readily available elsewhere.

The question of the correct distance of focussing reflectors is one which merits further discussion. Apparently, the existing usage in various laboratories differs considerably in this respect.

However, the alternative arrangement of an inclined mirror, permitting a longer distance from the source, has certainly advantages, and has been applied to our apparatus, in such a way as to enable any reasonable testing distance to be obtained. It occurs to me that, in Dr. Sharp's apparatus, the fact that the rays of light strike the mat surface at such an inclined angle seems a possible drawback.

I think Dr. Sharp rather over-estimates the difficulty of allowing for stray light. One would, however, naturally take other precautions when possible to reduce this correction, and would prefer a dark room when extreme accuracy is aimed at.

Yours truly,
J. S. DOW.

Colour Discrimination by Artificial Light.

SIR,—I was extremely interested in the discussion on the above subject in the February number of *The Illuminating Engineer*. The researches of Mr. Ritchie have evidently been made with extreme care, and yet I am of the opinion that at the present time the photography of coloured objects is still not an entirely reliable process.

We over here have likewise devised colour-boxes, wherein the effects of various illuminants, including the special 10 amp. colour-matching arc lamp can be studied. I have also added an apparatus making use of Luxfer prism glass by means of which daylight illumination can be directed upon a spot immediately below the boxes, where arrangements of coloured objects identical with those in the boxes are set out. Suitable screens can also be interposed by means of which the colour of the light can be regulated in each case so that the intensity of colour and depth of tone of the objects can be ascertained.

I have also made experiments with colour-filters consisting of a combination of cobalt-blue and nickel-green

glasses, and have noted with interest Mr. Trotter's remarks on this point. The suitable combination of these glasses demands great care in order to secure a suitable imitation of daylight, and yet to avoid excessive absorption of light. It is to be recommended that the cobalt and nickel ingredients should not be mixed or melted into the same glass screen, but that two separate glasses should be used. I have also found that the best results are secured when the green glass is the nearer to the light. In my experience the most satisfactory blue is the so-called "Königsblau" variety; for the green element nickel glass has proved to be the best. The proportions in which the glasses have to be combined naturally vary according to the lamp for which they are intended; for example, with osram lamps a combination of one blue glass with two green ones, but with a tantalum lamp one blue and one green glass give the best results. Special care must also be taken in the manufacture of these glasses in order to obtain a uniform distribution of density over the entire filter.

Gardner has shown that the excess of red rays can be filtered out by means of a solution of copper sulphate, but this screen is only suitable for arc and not for incandescent lamps. For the latter type of lamps, as suggested above, combinations of glasses are preferable. It may be added that *constancy of spectrum* is a very important quality to secure in a daylight-unit of this kind. Lack of permanence in the screen and variation in the spectrum of the source itself must both be guarded against.

In conclusion, it may be pointed out that a more exact definition of what constitutes daylight is needed. For example, the indirect illumination from diffused daylight differs essentially from direct sunlight. Possibly a spectrum corresponding with average conditions might be adopted and imitated in artificial daylight-units, and it may be hoped that we shall eventually have a more exact standard of what is required in this respect.

I am, &c.,

MAX PESCHKE.

(Holophane G.M.B.H., Berlin.)

The New Mazda House.

THE British Thomson-Houston Co., Ltd., have just opened their commanding new premises at 77, Upper Thames Street (London), and on April 29th an opportunity was given to members of the press to inspect the arrangements. As we go to press we can only refer very briefly to this interesting visit, but hope to say more on the subject in our next issue.

The new building has an impressive frontage, and a floor space of 20,000 ft. As one would naturally expect from a firm which makes a feature of illuminating engineering, the illumination of the offices is very good, and the scheme of light decoration employed throughout assists it considerably. The various floors are specifically devoted to carbon, gem, and Mazda lamps, which are systematically packed away in racks ready for dispatch. Many of the offices are lighted by indirect units on the well-known "Eye-Rest" system, four large units of this kind being employed in the entrance hall, while other rooms utilize appropriate Holophane reflectors spaced high up on the ceiling, out of the direct range of view.

It is anticipated that this new building will become one of the largest and most important centres for the rapid supply of lamps and wiring materials.

TRADE NOTES.

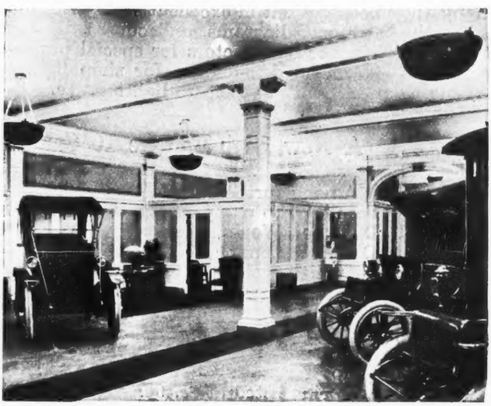
[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Indirect Lighting in Automobile Showrooms.

The premises illustrated herewith are those of the Chicago Motor Car Co., Michigan Avenue, and the form of lighting employed is the one known in England as the "Eye-Rest" system—marketed by the **British Thomson-Houston Company.**

The splendid effects of indirect illumination by this system can be well appreciated from the photograph reproduced on this page. Tungsten lamps are suspended within reflecting bowls of ornamental design, which direct the light against a bright ceiling, whence it is reflected and diffused throughout the entire space.



Such a system of indirect lighting is peculiarly suitable to automobile showrooms and garages because of its comparative freedom from shadows.

It is difficult, with any pendant or wall-bracket system of illumination, to avoid shadows at the sides of the cars, and automobile manufacturers will agree that for show purposes it is most desirable that every point and detail of a car should be well illuminated.

Welsbach Light for Private House Illumination.

For private house lighting by means of gas the **Welsbach Light Co., Ltd.** (Welsbach House, King's Cross, London, W.C.), is very fully equipped. Whether it is a question of providing a small cottage or a huge residential mansion with means for incandescent gas lighting, the large range of lighting appliances which the Welsbach Company exhibits is at once apparent after a visit to this company's well-equipped showroom at Welsbach House. Here everything is found in the way of Welsbach incandescent gas mantles, upright and inverted burners of a multitude of types, glass from the crudest design to the most artistic pattern, and fittings that would suit a great variety of tastes.

The principal branch of the Welsbach Company's business is, of course, the manufacture of Welsbach mantles, and they claim to manufacture a mantle that combines the maximum life with the maximum light.

We have previously referred to a little booklet, 'The Story of a Great Light,' recently issued by the Welsbach Company, which gives particulars of their standard mantles, upright and inverted, and also a short history of the origin of the Welsbach mantle.

The saying "The best is just good enough" might well be applied to the illumination of a private house by means of gas, and here the Welsbach mantle will doubtless satisfy the most exacting demands. In any case we recommend all lighting engineers to pay a visit to the Welsbach Company's showroom, where they will doubtless find a lot that will interest them from a gas illuminating point of view.

A New "Gem" Lamp.

The British Thomson-Houston Co., Ltd. (Mazda House, 77, Upper Thames Street, London, E.C.), have made an important addition to their range of Gem lamps by the production of a 30-watt lamp giving 10 c.-p.

Three sizes of Gem lamps are now available, viz., 30-watt, 10 c.-p.; 45-watt, 16 c.-p.; 50-watt, 20 c.-p., and their average lives are 1,000 hours, 1,500 hours, and 800 hours respectively. These lamps are supplied to operate singly on 100–130-volt circuits, and in series on 200–260-volt circuits.

For tramway service they can be used five in series on 500–600-volt circuits.

The B.T.H. Gem lamp satisfies the demand for a lamp which is more efficient than the carbon lamp, and yet cheaper in first cost than the metal filament lamp, and its field of usefulness has been very much extended by the production of the new 30-watt size.

Indirect Lighting by X-Ray Reflectors.

Our attention has been drawn by the **British Thomson-Houston Co.** to the fact that the system of indirect lighting employed in the large dome, referred to in our last issue (p. 168), is the same as that which they have introduced, under the title of the "Eye-Rest" system, in England. Those interested in this system of indirect lighting, which is carried out by means of Mazda lamps and X-Ray reflectors, will be glad to know that it is available here in England, and is not merely an example of what is done in America.

Spring Drum Electric Light Fittings.

We have received from **Messrs. Charles Joyner & Co., Ltd.** (Icknield Square, Birmingham), some particulars of SPRING-DRUM and other FLEXIBLE FITTINGS manufactured by them. Their spring-drum attachment for winding up loose flexible cord can be fitted to ordinary rise-and-fall pendants, and they also have a design for a table lamp with this arrangement concealed in the base. It is pointed out that by using the spring-drum ceiling rose, which will coil up as much as 50 ft. of flexible cord, a great economy can be effected in such premises as warehouses, where one portable lamp may easily do duty for six fixed lamps in lighting a range of bins or shelves.

New Catalogues.

Messrs. The General Electric Co., Ltd. (67, Queen Victoria Street, London, E.C.), have recently issued the 1911–12 edition of their complete bound catalogue. It has been brought out in four handsomely bound volumes, running into an aggregate of over 1,600 pages. Each of the four sections bears a distinctive colour, and each contains a complete index. A neat cabinet is provided to take the volumes, together with a loose-leaf binder, in which are to be inserted pamphlets issued from time to time to bring the catalogue up to date.

The apparatus dealt with includes almost every conceivable appliance connected with electric power, lighting, heating, signalling, telephony, &c. An interesting section at the commencement describes, with illustrations, the organization of the G.E.C., with its many factories, stores, and branch offices.

A very comprehensive catalogue of REFLECTORS and LIGHTING ACCESSORIES of all kinds has been sent to us by **Messrs. Schneider & Naujoks** (218, Mainzerlandstrasse, Frankfurt A.M.). The list has been got out in excellent style, with illustrations, diagrams, and curves. A large number of reflectors for special purposes is included, such as for shop lighting, desk lighting, picture lighting, &c.

A New High-Voltage 10 Candle-Power Lamp.

Among further particulars which have been sent to us by **Messrs. Siemens Bros. Dynamo Works, Ltd.** (Tyssen Street, Dalston, London, N.E.), regarding the new high voltage lamps of 10 and 16 candle-power now being placed on the market, we notice that the list price of these lamps will be 3*s.* 3*d.* We are also informed that 10 candle-power "Wotan" lamps for voltages between 90 and 130 are being listed at 2*s.* 6*d.* The efficiency of these lamps, which will have pure drawn tungsten filaments, will be approximately 1 watt per candle-power.

Contracts Closed.

We are informed that **Messrs. Siemens Bros. Dynamo Works, Ltd.,** have secured contracts for the supply of "Tantalum" and "Wotan" lamps to the following:—

Croydon Corporation (for the ensuing 12 months).

Pontypridd Urban District Council (for the ensuing 12 months).

Southampton Harbour Board.

Advances in Gas Lighting.

On pp. 259–61 in this number will be found an interesting account of the striking installation of shop lighting by gas carried out by Messrs. Ehrich & Grätz of Berlin, at the Women's Exhibition in that city.

We understand that the well-known firm of **Messrs. Krupka & Jacoby** (11, Queen Victoria Street, London) are the sole agents for the latest forms of Grätzin high-pressure lamps, some particulars of which will be found on p. iii. It may be added that Messrs. Krupka & Jacoby are also suppliers of electric lamps and fittings, being thus one of the up-to-date firms in this country that deal both with gas and electricity.

Mr. Sherard Cowper-Coles informs us that he severed his connexion some time ago with the Cowper-Coles Galvanizing Syndicate, and that he is in no way connected with the Magnet Galvanizing and Plating Co., Ltd., which has been formed to acquire the business of the Cowper-Coles Galvanizing Syndicate.

Long Range Illuminated Signs.

Messrs. Venner & Co. (6, Old Queen Street, Westminster, London, S.W.) have sent us some particulars of their ILLUMINATED SIGNS. These are characterized by the fact that they are specially designed so that they can be read at any angle, and, by the use of glass spheres, a very brilliant outline is obtained which can be clearly read at considerable distances. We note that the sign at the Coliseum has recently been converted from incandescent to arc lamps, and it is anticipated that this type of sign will be largely adopted.

As we go to press, **Messrs. Siemens** inform us of the following reduction in price of Wotan lamps :—

20–30 volt, 5, 10, and 16 c.-p., pear-shaped bulbs, 2*s.* 1*d.*

20–30 volt, 5, 10, and 16 c.-p., round bulbs, 2*s.* 4*d.*

Iron and Steel Institute—Annual Meeting.

The Annual Meeting of the Institute will be held at the Institution of Civil Engineers, Great George Street, Westminster, on May 9th and 10th, commencing each day at 10.30 A.M.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

Taking first the American contributions, we notice a series of papers before the Illuminating Engineering Society (U.S.A.) on **Artificial Daylight and Colour.** H. E. IVES discusses the effect of illuminants on the colour of objects mathematically, and concludes his paper by some comments on the essential factors in "daylight" illuminants. SHARP and MILLAR deal with the production of artificial daylight from the tungsten lamp, analyzing the relative advantages of coloured glass and gelatines for the work. Like other observers, they find that it is difficult to secure correct colour with an absorption of less than about 87 per cent. A method utilized by them is to mix the light, not by superimposing a green glass over a blue one, but by painting gelatines in alternate strips and using a diffusing glass plate in addition. R. B. HUSSEY describes a form of daylight unit consisting in a modification in the spectrum of the arclight by a suitable screen.

L. BELL (*Elec. World*, April 13) describes some researches on the comparative amounts of **Ultra-violet Light in Artificial Illuminants.** His method consists in the use of a screen to separate the ultra-violet from the visible and infra-red rays, and he then estimates the amount of radiation in this form by determination with a bolometer. Finally, he presents a table showing the amount of ultra-violet energy present, for a given illumination, in various artificial illuminants. He explains, however, that in all these cases reasonable precautions would prevent the rays having any injurious effect on eyesight.

W. E. BARROWS (*Elec. World*, March 23) presents a series of curves showing the effect of **Height of Suspension** on the illumination in the case of various groups of lamps. If the source consisted

of an evenly illuminated infinite plane, the height above the working plane would be immaterial, and, when lamps are spaced close together evenly and equipped with proper reflectors, this condition can be quite closely approached in practice.

R. Scott (*Elec. World*, Feb. 10) shows how small a percentage of the wages bill (usually well under 5 per cent) the actual expense of lighting represents. He also demonstrates how the improved output resulting from improved illumination can be expressed in graphical form and the value of good lighting brought home to manufacturers.

Turning next to German articles, we find a number of interesting contributions in *Licht und Lampe*. Lummer's contribution on the **Sensitiveness of the Eye and Radiation** is concluded, and there are several illustrated articles describing recent forms of decorative fittings. J. J. Schneider contends that the best criterion of the illuminating value of a lamp for street lighting is not the mean spherical candle-power as usually defined, but the "mean useful candle-power," by which he means simply the average of the candle-power in all directions.

In the *Zeitschrift für Beleuchtungswesen* (April 20) will be found an interesting historical note on some old lamps designed by Leonardo da Vinci, who appears to have actually utilized not only glass chimneys, but also water-lenses in order to concentrate the light. *Licht und Lampe* also describes an historical exhibition which recently took place in Copenhagen.

R. Stigler (*Akad. Wiss. Wien Sitz.*, July) contends that a distinct increase in sensitiveness in photometry, and—what is more important—greater comfort and ease in reading, are secured by using **Binocular Vision,** and he gives the results of some tests illustrating this.

ELECTRIC LIGHTING.

P. Amsler deals with **Train Lighting** (*E.T.Z.*, April 4). When the pressure is inconveniently high he recommends the use of a separate dynamo, and shows how the design of this can be arranged so as to give constant P.D. at the lamps with varying speed. J. Pole (*E.T.Z.*, Feb. 16) describes some experiments on **The Mercury Lamp.** He presents curves showing the distribution of brightness over the tube, the centre third being somewhat brighter than the extremities. He also discusses the relations which exist between efficiency, current, and dimensions of tube, pointing out that reduced diameter (as far as practicable) leads to improved efficiency. Finally, he points out under what conditions the light given by an A.C. lamp will be the same as that of a lamp of similar input using direct current.

W. Vieweger (*E.T.Z.*, April 18) points out that the recently imposed tax on carbons renders the need for economy more pressing, and suggests a method of making use of the residues left in the holders.

Among other articles we note the results of some tests of incandescent lamps on electric railways in the United States (*Elect. Ry. Journal*, Feb. 24), from which it appears that wire-drawn tungsten lamps are proving very acceptable. A writer in the *Elektrotechnischer Anzeiger* (March 7) analyzes the costs of electric lighting with glow-lamps of different c.-p. and cost, and presents the results in tabular form. The *Zeitschrift für Beleuchtungswesen* continues its series of articles on recent patents on the mounting of glowlamp filaments, new forms of arc lamps, &c.

GAS, OIL, ACETYLENE LIGHTING, &c.

An interesting lecture on **Street Lighting by Gas** was recently delivered by H. F. Cotton (*J.G.L.*, April 2). The first part of the discourse was devoted to an account of the early history of the subject, particulars being given of the lecturer's experience in Dublin. The requirements of street lighting are analyzed, and it is suggested that no street should have less than 0·007 c.-p. per square foot; also that a large number of small units is in general preferable to a few powerful ones. In conclusion, some different forms of torches, using benzine, acetylene, &c., are described. In the American papers some interesting examples are given of shop window lighting, and there is also an article showing the value of improved lighting in raising the status of a street. The findings of the **New York Public Service Commission on Pressure** (*Am. Gaslight Jour.*, April 8) are interesting. A minimum pressure of 2 in. and a maximum of 6 in. are prescribed, and it is added that the average daily variation should not exceed 2 in. Recommendations are also given on the maximum, momentary, and "pulsating" pressure variation. Several articles describe suspension arrangements for high candle-power lamps.

There are also several contributions dealing with the applications of **Acetylene in Mines and Churches,** and a comparative table of costs of electricity, spirit acetylene, &c., will be found in the *Rev. des Éclairages* (April 15).

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Eine historische Beleuchtungsaustellung (*Licht und Lampe*, April 11).
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Henry, —. Projecteurs électriques modernes (*L'Electricien*, April 13).
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Fortschritte in der Glühlampentechnik (*Z.f.B.*, March 30, April 10).
Neuere Bogenlampen (*Z.f.B.*, April 20).
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GAS, OIL, AND ACETYLENE LIGHTING.

Cotton, H. F. Improvements in Public Lighting (*J.G.L.*, April 2).
Caudwell, F. Domestic and Industrial Uses of Gas (*J.G.L.*, April 2).
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On dealing with Competition from Electricity (*G.W.*, April 20).
An Obscure Street lifted into Prominence by Gas Arcs (*Am. Gaslight Journal*, April 1).
New York Public Service Commission on Gas Pressures (*Am. Gaslight Journal*, April 8).
Outside Window Lighting (*Prog. Age*, April 1).
Selling Illumination to Stores (*Prog. Age*), April 15.
Suspension Gears for Gas Lamps (*Gas Engineer's Mag.*, April 15).
Aus der Gluhkörperfabrikation (*Z.f.B.*, March 30).
Aufszugvorrichtung für Pressluft-Gaslampen (*J.f.G.*, April 20).
Acetylene in Churches (*Acetylene Journal*, April).
L'Emploi de l'Acetylene dans les Mines de l'Est de la France (*Rev. des Eclairages*, March 31).
Le Coût comparé des Éclairages (*Rev. des Eclairages*, April 15).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. f. G.—*Journal für Gasbeleuchtung.*
J. G. L.—*Journal of Gaslighting.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

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The
ILLUMINATING ENGINEER
ELECTRICITY · ACETYLENE · OIL · GAS
Edited by
LEON GASTER

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EDITORIAL.

The Past Session of the Illuminating Engineering Society.

THE Third Annual Meeting of the Society was held on May 14th, and on p. 299 readers will find the customary Report of the Council. Progress is again satisfactory. The Society is emerging from its preliminary state of considering principles in illuminating engineering, and is passing on to practical applications. Definite recommendations will, it is hoped, be formulated before long by the Committees on Street, School, and Library Illumination.

It is gratifying to record an increase of nearly eighty in numbers, the membership of the Society now approaching 350. But, what is even more satisfactory to notice, the Society continues to attract the attention of eminent authorities in different parts of the world, and is fully maintaining its position as a truly international and impartial body. The Society has already made its influence felt in connexion with the important international congresses which have recently taken place on industrial hygiene and engineering, and it is shortly to be represented once more at the coming International Congress for the Prevention of Industrial Accidents in Milan. We regard participation in these international congresses as among the most valuable means of securing recognition of the aims and work of the Society, and we intend to deal specially with the proposed International Commission on Illumination, to be formed as a result of the resolution at the Turin International Electrotechnical Congress held last year.

The International Commission on Illumination.

This resolution sanctioning the initiative taken by the Illuminating Engineering Society of London to form an International Commission on

Illumination was certainly, for our movement, one of the most important events of the year. If this scheme can be carried to fruition, the Society will in this way alone have more than justified its existence. Preliminary negotiations are now going on and, as alternative schemes may possibly occur to others interested in the movement, we should like to take this opportunity of explaining our view as to how such a Commission should be composed in order to secure a permanent and satisfactory solution of the problems involved.

As regards the constitution of the Commission the first step will doubtless be the formation of national committees on lighting in the various countries (in the same way as has been done in the case of the very ably organized International Electrotechnical Commission). Delegates from these national committees, distributed according to a properly organised scheme, would form the International Commission. The national committees should obviously comply with two requirements (1) They should occupy an impartial position towards the various illuminants, gas, and electricity being equally represented, and (2) They should be so composed as to ensure due weight being given to the various non-engineering aspects of illumination, medical, architectural, &c., in the deliberations of the Committee. A third desirable requirement might also be mentioned, namely, that arrangements should be made for the representation of the various societies and associations interested in illumination—bodies whose influence could naturally aid the work of the committee considerably. We may also venture to hope that a committee so constituted would deserve and receive Government support.

We feel convinced that it is only by meeting all these requirements, and by establishing a Commission which is authoritative, impartial, and *really* international that a permanent solution of illuminating engineering problems can be obtained. We have many instances before us of committees which have done good work and are composed of very able members, and yet have failed to secure the necessary world-wide recognition. In each case there is the difficulty that they do not meet the conditions demanded of an ideal international and impartial body. Consequently their conclusions can only be accepted over a limited area.

Now it might perhaps be suggested that the required International Commission might be constituted by amending one of these existing committees. But it need hardly be pointed out how exceedingly difficult is such amendment in the case of an existing body constituted to do prescribed definite work and possibly tied to certain interests from which it derives support. Moreover it is highly probable that even were it found possible to extend the membership and functions of such a committee so as to give it the required international scope it would suffer from the fact of its having been originally connected mainly with a certain country or illuminant. To single out one of the existing committees, again, is in itself, apt to provoke jealousy and opposition on the part of the others. Finally there is the additional objection that the existing committees are almost entirely of a technical and engineering character. In order to enable them to deal widely with general problems of illumination it would be necessary to alter them out of all recognition.

For these reasons we hold that, in order to secure lasting success, the only satisfactory plan, would be to create a new Commission specially constituted for the purpose in view. This Commission would naturally take full advantage of the work done by other existing bodies and co-operate with them, as far as possible. In passing we should like to express our recognition of the very valuable service

accomplished by some existing associations and particularly of the admirable concerted photometric work now being undertaken by the authorized laboratories in this country, on the Continent, and in the United States.

The London Illuminating Engineering Society received a mandate from the electrical industry at Turin, and it is now desired to secure similar support from the gas industry. This, unfortunately, cannot be done quite so readily as in the case of the electrical industry, since there exists no similar organisation capable of doing for gas what the International Electrotechnical Commission does for electricity. We venture to suggest that the gas industry would greatly benefit by an organisation of this kind. There are many questions of international interest which such a Commission could settle, and, as suggested above, its formation should greatly simplify the task of forming the International Commission on Illumination. We put forward this suggestion as one which should appeal strongly to the gas industry, and we hope that it will find due support from the respective gas Institutions throughout the world.

The Title of "Illuminating Engineer."

There is one other section of the Report of the Council of the Illuminating Engineering Society on which we would lay special stress—that relating to the use of the title "Illuminating Engineer."

From the commencement of the career of the Society it has been recognized that membership in the Society does not confer the right to make use of this title. The Society is an Illuminating Engineering Society and *not* a Society of Illuminating Engineers. It has been from the first quite clear that this course should be followed, and members have honourably observed the traditions of the Society in this respect. For the present it is hardly possible to define the qualifications of the illuminating engineer precisely. Some men have specialized almost entirely in one branch of lighting, others are members of some recognized profession who take an interest in lighting matters. In neither case could the claim to be an illuminating engineer in the proper sense of the word be justified, and yet both men may be valued members of the Illuminating Engineering Society.

The career of the Society has been, as the President once happily put it, a career of self-education. During its first three years of existence a great deal has been learned. In course of time the Society will doubtless find itself in a better position to define more precisely what the qualifications of the illuminating engineer should be, and eventually obtain recognition for the title to be used. It is also conceivable that it might ultimately come to regard some other title as more appropriate to confer on its members.

Illuminating engineering is not a closed profession in the same sense as are the medical or legal professions; but the Society may be expected to exercise its influence to avoid the movement being brought into disrepute by people who profess to be illuminating engineers but may not have even studied the elements of the subject.

We insist upon this point, because our attention has been drawn to cases in which the term has been used by men who, in our opinion, have no claim whatever to be considered experts in lighting matters—who are not even members of our Society, or fully qualified members of any recognised established profession. The public must be warned against trusting the representations of such persons, and may rest assured that their claims receive no support whatever from the Council of the Illuminating Engineering Society.

A State Committee on the Hygienic Aspects of Lighting.

On pp. 284, 285 readers will find the text of several very important questions asked in the House of Commons by Mr. A. Lynch, M.P. on May 16th. The first of these related to the prevalence of miners' mystagmus which recent investigations by Dr. Llewellyn, Dr. Court, the late Dr. Thompson of Cardiff, and others ascribe to the inadequate lighting from miners' lamps. The other two questions called attention to the findings of the recent Departmental Committee on Accidents, which laid stress on the need for a standard of lighting in factories, and to the action of the French Government in appointing a Committee on the Hygienic Aspects of Lighting. It was pointed out that the recent Congress on Industrial Hygiene in Belgium had also devoted much consideration to the practical importance of good lighting and that at the International Congress in Turin in 1911 it was decided to appoint an International Commission on Illumination. In view of these facts, Mr. Lynch urged that a committee with similar aims to that formed in France should be established in this country. The Home Secretary (Mr. M'Kenna) replied that the matter had been under the consideration of his department for some time past and that he proposed in the near future to appoint a departmental committee to inquire into and report upon the subject.

To those concerned with illumination the Home Secretary's assurance will be very welcome. It is satisfactory to find that this country is not going to remain passive but proposes to co-operate in what other nations are doing. We have every reason to hope that the enterprising step taken by France will be followed elsewhere on the Continent so that we may see shortly established effective co-operation throughout Europe as well as in the United States.

At the same time we hope that the Home Office will not confine itself to the appointment of a departmental committee. It should also take note of the findings of this committee and subsequently apply the results in all directions concerned with the proper use of light from the hygienic standpoint and as a precaution against accidents. The questions which have been specially brought before the notice of the Home Secretary are in themselves exceedingly complex and important, and there are many others which might well fall within the scope of the proposed Commission. On all such points what is needed is a really impartial and authoritative investigation, and the very best expert advice would be required. It is also essential to give the conclusions reached the widest possible publicity.

We hold that this question of good illumination is one of national importance. It affects directly the very large number of people in this country connected with the lighting industry. But good lighting is a necessity wherever work is carried on and the influence on health and loss of time and labour through defective conditions of illumination in the schools and factories of England alone is simply incalculable.

Some of our members have expressed the hope that the time is not far distant when we will see the appointment of a Royal Commission, on which representatives of the various systems of illumination and the technical, medical, architectural and other aspects of the subject will be adequately represented.

In conclusion, we should like to express our appreciation of the service done by Mr. Lynch in drawing attention to these matters in the House, and to the Home Secretary for the sympathy shown in the aims and work of the Illuminating Engineering Society. Needless to say, we shall be only too glad to render any possible assistance in this matter, and would be prepared to give wide circulation to any useful information placed at our disposal on this subject.

LEON GASTER.

Review of Contents of this Issue.

THE TECHNICAL SECTION in the present number opens with an article on the **Lighting of Cotton Mills** (p. 279). The author discusses the requirements for work of this kind, pointing out the necessity for good illumination when complicated machinery and intricate manipulation of the tread-thread have to be supervised. Good daylight is also essential. Prismatic glassware is coming into use in order to improve the natural conditions and the shape of modern buildings is also being designed to the same end.

Following this will be found the text of several important questions asked in the House of Commons by MR. ARTHUR LYNCH, urging the value of a Commission on the **Hygienic Aspects of Illumination.** It is pointed out that a precedent in this direction has been established by the action of the French Government, and that stress was laid on the claims of good illumination in factories by the recent Departmental Committee on Accidents. Another instance of a problem needing investigation is "miner's nystagmus," which appears to be partly due to defective lighting. In reply to these questions the Home Secretary states that he is favourably considering the matter, and that it is proposed to appoint a departmental committee on illumination very shortly. Another matter discussed is the lighting of the House of Commons.

On p. 278 will be found short notes relating to the recent Photographic Exhibition, and the change in public opinion as regards illumination in Germany since the beginning of the last century. An interesting article from a German paper of 1817 on this subject is quoted. On p. 286 will be found an illustrated account of some ingenious forms of Table Lamps made of crockery ware.

Following this will be found the the portion of the magazine devoted to the *Transactions* of the **Illuminating Engineering Society.** The discussion on the papers by Mr. W. R. Rawlings and W. H. Y. Webber on **Private House Lighting** is reproduced. The majority of the speakers concede the view that the opinions of the consumer require to be consulted to an exceptional extent in this branch of lighting; on the other hand several common faults in lighting are pointed out. It is suggested that the illuminating engineer could often give valuable advice, and, when these matters have been more completely threshed out, should be in a stronger position to put his views forward.

The next item is the account of the **Annual General Meeting** (pp. 296–98), the report of the Council was presented, several minor alterations in the constitution of the Society were made, and the customary formal resolutions passed. The **Report of the Council** is given *in extenso* (pp. 299–305). Points that receive special comment are the growing international connexion of the Society and the vista of important work that is opening up. One of the most important events of the year is the resolution sanctioning the formation of an International Commission on Illumination. In addition, valuable practical work will, it is expected, be performed by the Joint Committees on School, Street, and Library Lighting now in existence. The Hon. Secretary is about to undertake a tour on the Continent and in the United States, which will, it is hoped, lead to further co-operation. The membership of the Society now exceeds 340, and, apart from this great numerical increase during the season, the support of many distinguished authorities throughout the world has been secured. This is illustrated by the complete list of members reprinted in the present number.

At the end of the number will be found the usual **Review of the Technical Press** and the **Trade Notes.**

The Photographic Exhibition at the Horticultural Hall (Westminster).

AT the Photographic Arts and Crafts Exhibition which has recently terminated at the Horticultural Hall, quite a number of exhibits of more than casual interest to lighting engineers were to be seen. There were of course displays of many varieties of cameras and photographic accessories, including the new "Hydra" plate of the Paget Prize Plate Co. which is stated to be incapable of over-exposure. There were also a number of striking photographic art reproductions and examples of colour photography. A notable stall was that of Messrs. R. & J. Beck Ltd. where demonstrations of lens work the absorption of various glasses, methods of detecting striation, &c. were to be seen.

Another feature of the exhibition was cinematograph and projection apparatus. The small automatic enclosed arc for projection work of the Westminster Engineering Co. using $2\frac{1}{2}$ to $4\frac{1}{2}$ amperes was of interest, the two carbons being mounted at right angles. Another compact lamp of this kind is the "Klimax" (W. Butcher & Sons), in which the carbons are mounted horizontally and parallel, and can be fed towards the condenser by a simple twisting movement. This arrangement is claimed to have the great advantage of removing all obstruction to the light due to the carbons.

A Century of German Gas Lighting, 1912 and 1819.

BY AN ENGINEERING CORRESPONDENT.

IT is now just a hundred years since gas lighting was introduced into Germany. The novelty was due to the mining and metallurgical engineer, Prof. Lampadius of Freiberg in Saxony, who lighted his dwelling with the new illuminant.

Even in the nineteenth century its introduction was no easy matter. The *Kölnische Zeitung* for March 28th, 1819, gives seven reasons against its introduction :—

1. Theological.—The use of gas would counteract the general plan of nature, by which there must be darkness by night.

2. Medical.—The vapours would be injurious, the bright light would induce people to remain in the streets too long at night, and cause an increase in the number of colds.

3. Legal.—Gas lighting must be introduced at public expense, and the cost would be borne by people who would not desire the extra illumination.

4. Moral.—The fear of darkness, which deters many weak persons from sin, would disappear, and drunkenness and immorality would be increased.

5. From the standpoint of the police.—Horses would shy, and thieves be emboldened.

6. Economic.—Large sums of money would find their way yearly abroad.

7. Popular.—The effect of the usual illuminations on national holidays would be diminished by the daily lighting up.

It appears, however, that these arguments were not considered as unanswerable, and, indeed, since that day illumination has been found to have almost an exactly opposite effect to that feared—*e.g.*, it is now regarded as essential to health and its provision as a public duty ; it is also one of the most valuable aids to the police. Again modern methods of lighting add greatly to the effectiveness of spectacular effects, which have lost none of their popularity.

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

The Illumination of Cotton Mills.

By A Textile Correspondent.

Our greatest indoor industry — the manufacture of cotton in all its branches —has suffered long and seriously from the indifferent illumination of its operative establishments. Up to recently it was, indeed, a rare discovery to find a cotton mill adequately lighted by artificial means. And even to-day the illumination of spinning-rooms and weaving-sheds generally is below what may be reasonably expected, when we consider the means which modern science has placed within our reach for effective improvement.

Necessity for Good Lighting.

In few, if any, occupations is the need for good lighting more essential than in the cotton industry. And indifference in this respect is often answerable for severe accidents, defective eyesight, and poor production. The processes in cotton mills are highly technical; and the best possible illumination is of the greatest import when weavers are dealing with 40 to 60 threads to the lineal inch, or spinners are watching a thousand threads of eighties counts throughout the length of a spinning-mule. When threads snap (as they do on all looms and frames), it is necessary not only to see where they snap, but how to piece them; and a weaver's knot is a piece of work which requires to be seen to be properly executed. Besides, every machine in the cotton mill bristles with wheels of a more or less dangerous character. And although many of these are so guarded that operatives would not be likely to receive injury in the ordinary course of their employment in daylight, the situation is materially changed when these machines are shrouded in semi-darkness. Driving pulleys and belts of several machines are uncovered for practical reasons; such machines, for example, are carding engines,

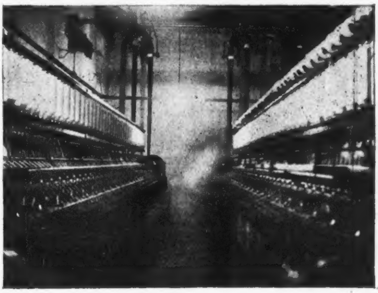

Fig. 1.—Roving frames (running at full speed) in a cotton mill lighted by incandescent gas. Photograph taken at night.

slubbing frames, intermediates, and roving frames. Bad lighting of these parts may, at any moment, be the direct cause of serious accidents to operatives, passing and repassing without being able to estimate their nearness to points of danger.

In old mills the floors are still to be found made of stone flags, sadly lacking in common level, with pieces broken off, and gaps left which are veritable traps to the unwary. It will be per-

fectly obvious that a slip here in the dark, near dangerous parts of the machinery, may be fraught with hazardous consequences.

Furthermore, in card-rooms, winding rooms, and mule rooms rails are laid

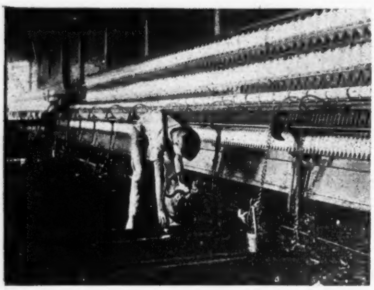

FIG. 2.—Jenny-gate (mule-room) of a cotton mill, showing dark floor and wheel rails. Note the complexity of the machinery and the need for good illumination.

on the floors for the purpose of transferring the material on bogeys or trucks from these rooms to other departments of the mill. These rails, from constant usage, become as slippery as glass; and it is adequate illumination more than any other factor which prevents them being fruitful sources of accident. In the "jenny gate," that is the space between each pair of mules, the rails on which the carriage wheels run are raised above the floor level from one to four inches. What then must a badly lighted jenny gate mean to the men and boys who are constantly crossing these rails with bare feet! It is little wonder that, with the greatest possible care on their part, they have toes knocked up, feet cut, and heels bruised. Such incidents seldom happen in a well-lighted jenny gate.

Accidents in the Dark.

Although, in point of fact, the greatest number of accidents occur between 10 and 12 o'clock in the forenoon, and between 3 and 5 o'clock in the afternoon, it frequently happens that very serious casualties transpire in semi-darkness. An operative slips and falls on a badly lighted floor, and is powerless to avoid collision with a machine in close proximity. An attendant is cleaning the iron-plate guards which cover the intake of dangerous wheels, when her cleaning-cloth goes beyond the guard and becomes enmeshed in the wheels, her hand probably following the cloth. A spinner is oiling his machine in the dim twilight, when it is extremely difficult to see the oil-

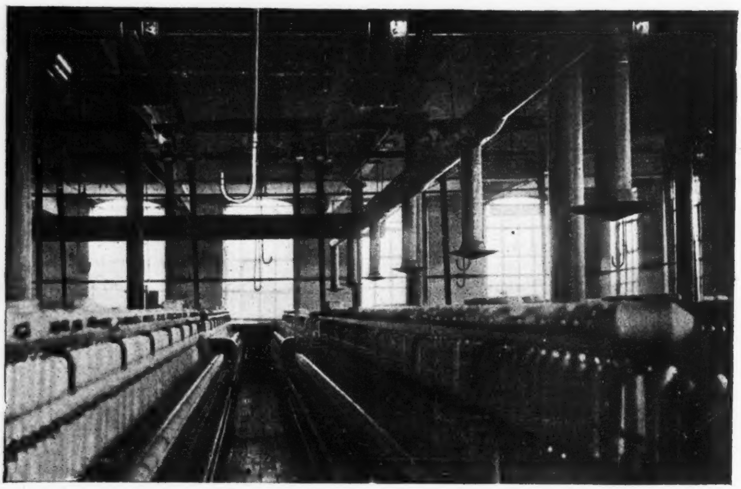

FIG. 3.—Showing good daylight illumination of passages in a Ring-spinning room. Note also pipes from ceiling terminating in flat-flame burners.

holes. He cautiously adopts his forefinger as an indicator, and is seized in the dark by wheels close by.

In mills erected twenty to thirty years ago machines are frequently placed so near each other that there is barely room to pass between. Card-room operatives, with loose clothing, run considerable risk among these machines when the passages are in darkness. Similarly, stairways suffer from bad illumination. One dim gas light at each angle of the stairs is often counted sufficient, and these being of stone operatives are liable to fall through being unable to distinguish the edges of the steps. A false sense of economy is sometimes the cause of these steps being in total darkness until close on 6 A.M. It is a profound mistake to have scores of operatives ascending and descending several flights of stone steps without proper illuminants.

Present Stage of Progress.

The apathy which has checked the progress of mill lighting is, perhaps, somewhat due to lack of standards. We have already standards of temperature with which workrooms may be compared by the thermometer. We have also standards of ventilation determined by the anemometer. But photometric calculations and standardizing in cotton mills is practically an "unknown quantity." And until we possess some adequate and convenient means of surmounting this difficulty mill lighting is likely to suffer.

Quite recently—after a century of cotton mills—basement rooms have been wonderfully improved by the introduction of prismatic glass as a substitute for the old-time small panes of greenish-tinted material. It is now becoming apparent to leading manufacturers that direct skylight, through a prism, is of far greater working value than the light reflected from brick walls and assisted by poor gas jets. Direct sunlight is now admissible in rooms where aforetime it was impossible. In cotton-land, innovations of this character move slowly; but signs are not wanting that prismatic glass for the lower rooms of cotton mills will, ere long, be generally adopted.

For artificial lighting some cotton mills still hold tenaciously to the antiquated use of gas jets with small burners. The illumination from these is much below the standard required for the technical work involved. But custom dies hard. This form of gas illumination availed a century ago; and it must, forsooth, avail now. Ten years ago it was a rare occurrence to find a mill with the more modern methods of illumination. Single jets of coal gas were placed high above the heads of the workers, and fixed 15 to 20 feet apart. Obviously such a system of illumination was wanting in efficiency.

When the mill building boom arose a distinct advance was made. The new mills were provided with costly installations of electricity for lighting purposes only. Electric generators are connected to main engines; and every room in the mill is amply provided with incandescent lamps set about 12 to 15 feet apart, according to the requirements of the various occupations.

Improved Methods of Illumination.

The illuminant of a cotton mill must be constant, uniform, and penetrating, and the gas mantle, is now very generally approved as adequately meeting these conditions. Spinners can see their work more clearly than ever during the dark hours at the extremities of the working day; where reflectors are adopted the floor is often more plainly visible than in the daylight.

There is a prominent future for the incandescent mantle in other departments of the industry. Its adoption in weaving sheds is growing in popularity. Time was when weavers dreaded the approach of dark days, because these meant arduous work and a reduction in wage-earning capacity. Such fears may now be entirely allayed; the widespread use of "incandescent" has so considerably enhanced the illumination of the shed. Breakage is one of the main drawbacks to the employment of mantles; but with the constant attention of inventors to stronger types this item is not likely to prove serious.

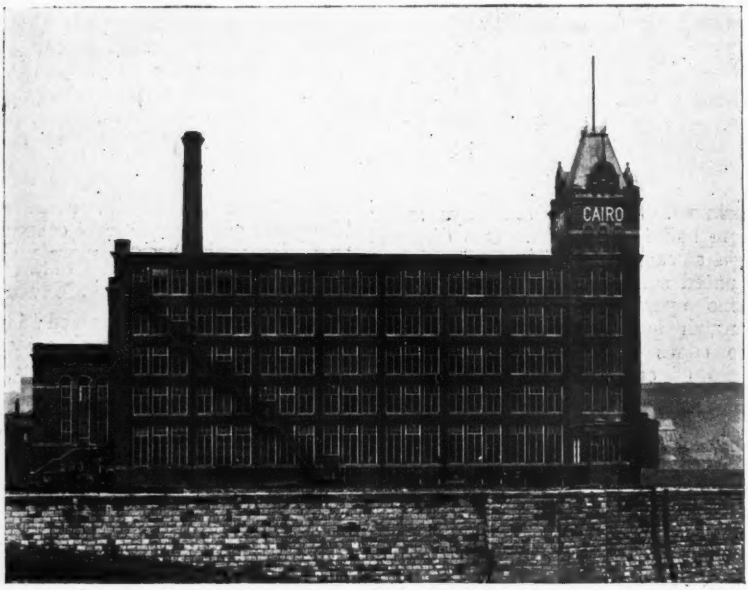

FIG. 4.—Cairo Mill, Oldham. Showing arrangement of windows to secure a maximum daylight illumination. To increase the illumination, prismatic glass may be utilised.

FIG. 5.—Cromer Ring-Spinning Mill, Middleton. Showing arrangement of rooms on one floor, with skylight illumination.

Quite recently several large cotton mills have adopted artificial silk mantles, which are held to be more reliable and permanent than cotton fibre.

OTHER ILLUMINANTS IN THE FIELD.

Sundry experiments have been attempted with electric arc-lamps in opal or frosted glass; but unduly dense shadows must be avoided, and a type in which "flickering" occurred could never meet with universal adoption in cotton mills. A more recent method has been the use of inverted arc lights with reflectors, and if these were carefully distributed there is much to be said in their favour.

Time and experiment will be necessary to show the part to be played by the electric metallic filament lamps for cotton mill lighting. In weaving sheds, at any rate, there would be ample opportunities for testing their relative value as compared with earlier illuminants. Manufacturers generally are not disposed to halt at reasonable expense. What they, as well as the working operatives, mainly desire is to secure the best practicable illuminants for their mills.

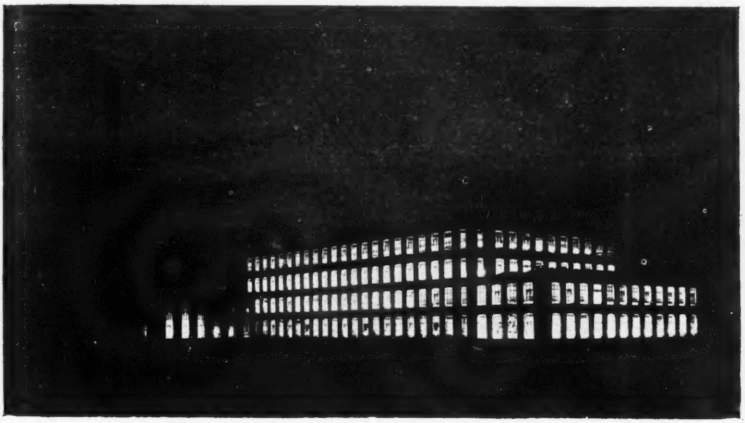

FIG. 6.—Cotton Mill illuminated by incandescent gas mantles. Photograph taken at night.

The Optical Convention.

DURING the present month the Optical Convention is to take place in the building of the Natural History Museum, South Kensington, and we propose to deal with the proceedings in our next number.

The occasion, it is hoped, will serve to show the progress that is being made in the manufacture of optical apparatus, and we understand that illumination will also be represented. A section will be devoted to recent developments in shades and reflectors, and papers dealing with photometry and other subjects will be read.

The Convention has received influential support, and will doubtless be of interest to many readers of this journal. Developments in optics now take place so rapidly that there is a need for occasional displays of this kind.

Moreover, the problems in illumination with which we are concerned are closely connected with the principles of optics. The study of scientific prismatic glassware implies a knowledge of the laws of refraction, and again reflection from polished and diffusing surfaces plays a considerable part in illuminating engineering apparatus.

Questions in the House of Commons on Illumination.

On Thursday, May 16th a series of questions on important matters connected with illumination were asked by Mr. Arthur Lynch M.P. Three of these, addressed to the Home Secretary, related to the desired appointment of a Commission on the Hygienic Aspects of Illumination in this country, stress being laid on the important work such a Committee might do in connexion with the lighting of mines and factories. The matter is commented upon in the editorial in this number.

In what follows we give the official text of these inquiries. All interested in the illuminating engineering movement will recognize the important precedent established by the official encouragement of the need for an investigation on the hygiene of illumination, and will appreciate the great service done by Mr. Lynch in calling attention to this subject.

" Q. Mr. Lynch,—To ask the Secretary of State for the Home Department, whether he is aware that last year 1,618 men in the United Kngidom received compensation in regard to miners' mystagmus, and that in a paper presented to the Royal Society (Series B 576), Dr. Llewellyn attributed the disease in great part to defective light; and whether he will take steps to have the whole question of the illumination of mines investigated as, for example, by a special commission.

" A. Mr. Secretary M'Kenna.—The figure in the Question is that for 1910, as given in the Home Office statistics; the figure for 1911 is not yet available. I am aware of Dr. Llewellyn's researches, and understand that they are still being continued. The illuminating power of miners' lamps is one of the matters which will be taken into account in approving lamps under the provisions of the new Coal Mines Act, and the point is under the consideration of the committee which is now engaged in formulating the test. I also hope that the competition which is now proceeding for the prize offered for the best electric miner's lamp will help greatly towards an improvement in the illumination of mines. I do not think that there is a case for instituting a further special inquiry at the present time.

" Q. Mr. Lynch,—To ask the Secretary of State for the Home Department, whether his attention has been called to the fact that in the Report of the Departmental Committee on Accidents, 1911 (Cd. 5535), on page 81, the necessity is indicated of fixing standards for lighting; and whether he can state what steps, if any, he proposes to take to carry this recommendation into effect.

" A. Mr. Secretary M'Kenna.—The subject has been under the consideration of my department for some time past, with reference both to the recommendation of the Accidents Committee and also to the work which is being done on the Continent in the matter, and preliminary investigations have already been made. The questions involved are very complex and technical, and I propose in the near future to appoint a departmental committee of an expert character to report on the subject.

" Q. Mr. Lynch,—To ask the Secretary of State for the Home Department, whether his attention has been called to the fact that in the chief Continental countries the whole question of illuminants is receiving attention; that France has appointed a special committee to study the question exhaustively, and with especial regard to the lighting of factories, mines, and public buildings; that in Belgium a congress has devoted much consideration to the matter; that Holland has established a minimum standard for lighting factories; and that at the International Electrical Congress of

Turin, 1911, it was decided to proceed to the formation of an international lighting committee; and whether, in view of the greater interests of this Country involved in the question, steps will be taken to co-operate in this movement, and that a special commission on the subject be appointed.

"A. Mr. Secretary M'Kenna.—The Answer which I have just given to the honourable Member's previous Question answers, I think, this Question also."

Mr. Lynch also addressed an inquiry to Mr. Wedgwood Benn, representing the First Commissioner of Works, with regard to the lighting of the House of Commons. It will be recalled that in a recent editorial on this subject it was suggested that the matter was not one to be lightly decided on the advice of a single oculist, however eminent; and that the problem involved many points of a technical kind that were not within his province. This aspect of the matter was emphasized by Mr. Lynch, who urged that a properly constituted Commission should be appointed to consider the question.

In reply, Mr. Wedgewood Benn said that the report of Dr. Collins would be available in the course of a few days, and that the First Commissioner of Works, after consultation with his adviser on hygienic matters, was also in favour of the proposed changes.

Answering further questions, Mr. Wedgewood Benn explained that at present the lighting was carried out by gas, but that a single panel had been experimentally equipped with electric light. When the change was completed, the effect would not be glaring, and in this respect it would be difficult to detect any change from the present conditions.

We still hold the view that the lighting of the House of Commons deserves the attention of a committee of experts specially constituted for the purpose. But it is at least interesting to note the increased importance now attached to hygiene and the absence of glare—questions which might hardly have received consideration a few years ago.

Lighting the House of Commons in 1838.

The lighting of the House of Commons has recently been much commented upon. *The Co-partnership Journal* gives an amusing account of a letter written by Lady Louisa Molyneux to Mr. Creevey, dated Jan. 17th, 1838, which contains the following allusion to the lighting of the then newly erected Houses of Parliament :—

"Byng & Co. have tried, it seems, rather a dangerous experiment with the House of Commons, which they lighted so brilliantly that you could read the smallest print, and if you held a candle to the paper it added no light to the dazzling glare, which came from 5,000 apertures in *gas pipes* between the roofs, where the thermometer was at 120 and kept rising. They had fire engines in attendance, and a hose laid along every gas pipe for fear of accidents, but they will not venture to try it again."

Table Lamps of Glazed Pottery.

A NOVEL development in the use of pottery for electric table lamps is described in a recent number of the American *Illuminating Engineer*, and we reproduce herewith some examples. These lamps are formed in two parts—the base and the shade, each of which is of thick pottery. The electrical parts of the lamp are carefully concealed, so as not to spoil the effect of the pottery. The lamp-holder (usually of the Benjamin cluster form) is fixed to the top of the base, and a push switch is fitted in the lower part, a small ebony button being the only visible evidence of this.

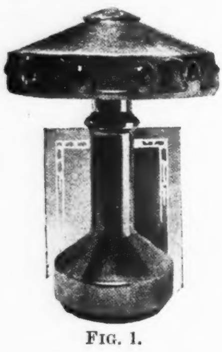

FIG. 1.

Besides their unusual shape, the lamps depend largely for their effect on the various artistic glazes which are used in finishing the surfaces. For example, matt green or yellow is sometimes employed, and where an antique finish is desired, as in Fig. 1, some of the ancient Chinese glazes, such as blue or pink, have been used with good effect.

Fig. 2 shows a type of lamp in which the base has been made large compared with the shade; this type, it is suggested, would be effective in a low-

FIG. 2.

built room, on account of its breadth of horizontal line. A fairly wide distribution of light is given by the shade in Fig. 3, which shows a more simple design, the ornament being confined to the shade.

FIG. 3.

The use of art pottery of this kind for table lamps is an interesting departure, and the examples here reproduced will serve to show the possibilities it affords of combining decorative effect with practical utility.

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

(The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.)

Private House Lighting.

DISCUSSION.

[Discussion of two papers by Mr. W. R. Rawlings and Mr. W. H. Y. Webber on the Lighting of Private Houses by Electricity and Gas respectively, read at a meeting of the Illuminating Engineering Society, at the House of the Royal Society of Arts (London), on Tuesday, April 16th, 1912. See *ante*, pp. 235-258, May, 1912.]

THE CHAIRMAN, in declaring the discussion open, said there were many very human touches in both papers, which were in the nature of philosophical, literary, and even humorous dissertations, rather than strictly technical contributions. They were fully up to the standard of the Society's transactions. He agreed with both authors that the problem under discussion was one of convenience, taste, and personal requirements rather than one of foot-candles, and, as Mr. Webber said, it was one for proper distribution of lights rather than mere candle-power. It was very difficult to lay down any rules in regard to house lighting, because there the variations of individual taste played their part more strongly than in any other problem of illumination. Nevertheless, Mr. Rawling's paper had laid down certain general rules which might be observed with advantage, and Mr. Webber had made a number of very practical suggestions which would be of use to any one planning the lighting of a private house.

MR. J. DARCH expressed the view that many of the illustrations in the papers did not exemplify those principles which the Society was trying to advocate. Some of the pictures that had been shown represented the methods of twenty years ago. Nevertheless, he was pleased to note that Mr. Rawlings had given five very excellent rules, although, in the examples produced, they were not followed. He took exception, however, to the first rule. To say that illumination should be uneven was to begin at the wrong end. Every scheme should start with a basis of even general illumination ; the things in a room are there to be seen, and require a low or high general illumination according to the character of the room. The decoration should afford the necessary relief to the eyes at night as in daylight. To this should be added the local lighting, again according to requirements. This would give us a rational and proper uneven illumination exactly adapted to requirements, and not one that is made uneven just for the sake of making it so.

Apart from this he could strongly recommend Mr. Rawlings's five rules. He would like to point out, however, that the second rule relating to lights in the line of vision, had been largely disregarded in the illustrations which Mr. Rawlings had shown. He disagreed with the policy of putting a transparency over a lamp and describing it as " well shaded." Some of the shades shown in connexion with both papers were so transparent that the lamps could be seen inside them. He considered that if a shade had an intrinsic brilliancy exceeding one-tenth candle-power per square inch, it was injurious to the eyes and contrary to Mr. Rawlings's own second rule. This of course applied equally to gas and electric lighting.

Indirect lighting had been described as shadowless, but in his opinion it

was very far from being so, since it resembled daylight which no one would call "shadowless." He did not, as a rule advocate indirect lighting for living rooms, but there were many large drawing-rooms which would be usefully illuminated by this means, and he could not understand any one preferring a room where he had the glare of a lamp in front of his eyes. He hoped we had not forgotten the physiological papers with which this Society began its work.

At present we seemed to be still influenced by what our mothers and fathers had taught us, but he hoped that in course of time these old-fashioned prejudices in lighting would give place to those better and more scientific methods that this Society was formed to bring about.

MR. A. P. TROTTER agreed that the questions dealt with in the paper were largely matters of taste and of individual predilections, and it was difficult, therefore, to be didactic. Nevertheless, he would quarrel with Mr. Darch upon some of the matters which he had raised. First, with regard to uniform illumination. In a private library or dining-room it was not necessary to have uniform artificial illumination all over the room. At the same time, there were kinds of public lighting where it was necessary to have at least a minimum illumination. In his own office, however, he did not by any means have uniform illumination. His table was well lighted, but the rest of the room was in comparative darkness.

He once showed at an early meeting of the Society a shade which he used for his own domestic purposes. He happened to have a number of old French sconces, candle fittings, and he agreed with Mr. Webber that the artificial candle was rather an eyesore. Instead of using a piece of white opal tube, he used a bit of brass tube tinted to suit the ormolu of which the sconces were made. That did not pretend to be a candle, but it carried out the idea artistically. With regard to the small shades or shields, about 3 in. across, which were frequently used in front of the candle, if these were transparent enough to let a fair amount of light through, the intrinsic brilliance would be too much for the eye, but if they had opal glass, or ground glass, or paper, with a white wall behind, an illumination was obtained which was very uniform to look at, and the intrinsic brilliance of the shade was not much different to that of the wall. He preferred white, which gave a very uniform appearance upon the wall, together with a high efficiency of illumination.

He was disappointed at present in domestic electric lighting with metal filament lamps. He agreed with Mr. Rawlings that the yellow rays gave greater satisfaction, and in spite of what Mr. Darch had said about not being old-fashioned, he agreed with Mr. Webber with regard to the old-fashioned mellow light. It was astonishing how it was possible to accommodate oneself to what would be called poor lighting. He had been spending a week-end in an old farmhouse a good many miles away from any gas works, where there were whitewashed ceilings and walls, and a good deal of oak timber. The lighting was by two "Princess" paraffin lamps, which he roughly photometered as giving $1\frac{1}{2}$ candle-power each, but he and his friends had managed to read very comfortably with this light. At one time they had a blaze of light from two candles in addition, but he dispensed with these in order to see what they could do, and they did fairly well with the paraffin lamps. On the other hand, with electric light, they were forced to go to the other extreme, and use large candle-power metal filament lamps, but the iris of the eye contracted in order to save the unfortunate retina, and therefore it did not get so much light after all.

Cornice lighting, he thought, was a plaything. He believed that he put in one of the first examples of cornice lighting about twenty-eight years ago in the house of Mr. Henry Tate at Streatham, but he regarded it only as a thing to supplement the ordinary lighting in a large house. The whole question was one of taste and personal feeling, and he agreed with Mr. Rawlings

that it was a very good thing to educate the people in this matter. A friend of his had electric light in his house, and would not have a single shade of any sort.

Mr. J. G. Clark agreed with Mr. Rawlings that any attempt to impose scientific principles upon a consumer against his wishes would not meet with very much success A good way for dealing with private house lighting would be to have a number of rooms of different kinds lighted so that the prospective purchaser could visit them and obtain a proper idea of what he should use in his own house. He showed two illustrations of drawing-room lighting where candle fittings were used (see Figs. 1 and 2), and thought that perhaps Mr. Webber, after seeing these, might be converted to the view that under some circumstances a candle fitting was useful. In one case the candle fittings were surrounded by light pink silk shades, and gave a very effective appearance. In the other case the room was lighted in a similar manner by candle fittings, the walls being of a light colour. Shades were an important matter in effective illumination of this kind, and he knew of a number of people who kept a stock of different coloured shades, which they changed frome time to time.

He had some photometric data respecting the illumination in the rooms that were illustrated, but he did not think the matter worth bringing forward, except just to say that from 2 to 3 foot-candles could be obtained upon a book at practically any part of the room, and a surface brightness of from 1 to 2 foot-candles upon the walls.

Mr. V. H. Mackinney, dealing with Mr. Darch's remark that the surface brightness from a shade should not exceed one-tenth candle per square inch, expressed the opinion that 1 candle per square inch was not excessive, and thought the public would not desire anything less than that. With reference to uniform illumination, he thought one should be clear as to what was actually meant by this term. For example, he had in mind a combined dining and sitting room lighted from the centre. The highest horizontal illumination was located over the centre of the dining-table, where it was needed; but there was also an illumination of about the same value in the plane in which one would hold a book or paper for reading when seated in front of the fire, although the horizontal illumination would naturally be much less. He had taken some measurements in this room, and found that the illumination over the horizontal working plane, about 2 ft. 6 in. above the floor level, was by no means uniform. It was about 3 foot-candles in the centre, with all the lights on, and about $\frac{1}{2}$ foot-candle over the wall, and when he held a book in the arm-chair near the fire he got on that book about $2\frac{1}{2}$ foot-candles, so that, although there was nothing like uniform horizontal illumination throughout the room, yet there was uniform illumination in the *working positions*. He showed two slides to illustrate this. In such a room it was also necessary, without using wall brackets, to have a fairly average illumination on the walls, and in the room referred to this did not go lower than $\frac{1}{2}$ foot-candle right near the floor, and it did not exceed 0·7 foot-candle near the ceiling; this, he thought, was a good uniform illumination, desirable in a room of that description. Further, in order to give a cheerful effect, the surface brightness of the walls should not fall below $\frac{1}{4}$–$\frac{1}{3}$ foot-candle, and the average in this dining-room was about 0·27. The reflecting power of the wall paper was about 36 per cent. The ceiling brightness was about $\frac{1}{2}$ foot-candle.

Mr. E. Lovinson said he frequently came across houses of the lower middle class where the illumination was abominable, and a little consideration would do a great deal towards improving these lighting conditions. At present, private houses were lighted mostly on the advice of the owners themselves, who, however, should go to an illuminating engineer, and get some good advice. He thought it would pay him in the

end. He thought that sufficient attention had hardly been drawn to pneumatic distance lighting for gas lighting, as considerable improvements in this direction had recently been made. A great deal had yet to be done with regard to guarding the eye from the actual glare of the light. At present, too much of the filament or mantle was frequently visible, and the more successfully these were screened the better the effect on the eye. He would also have liked to have heard something more about the effect of colour of wall papers in connexion with illumination.

Mr. Haydn T. Harrison said that during the last ten years he had been advising people on the lighting of their houses. They let him advise them as far as such details as mains, position of the switches, &c., but when it came to the position of the lamps and what sort of fittings should be used they accepted his advice, but rarely acted upon it. He remembered an occasion when, after he had talked to the lady of the house for two hours, not a single light was finally installed in the position he had intended. He suggested that the home was the one place where a person should be allowed a great deal of freedom in arranging the lighting.

There was one special point he would like to refer to, and that was the lighting of billiard tables. In all his illustrations Mr. Rawlings had shown six lights over the table. He had found out that to light a billiard table satisfactorily there must be eight lamps over it. The theory came about that six lamps should be used because there were six pockets, but it was quite erroneous, and it would be found that with eight lamps a very even distribution could be obtained. The argument that the extra lamps interfered with the head of the player was not borne out in practice.

With reference to Mr. Webber's drawing of a £40 a year house, he noticed that the control of the lamps was divided into three different methods —electric control, pneumatic control, and hand control. He would like to ask if by hand control was meant a by-pass lamp or a hand-lighted lamp or mantle; he did not quite understand why if pneumatic or electric control was installed hand control was needed as well.

Prof. J. T. Morris, whilst agreeing that this matter was almost entirely a question of taste, said there were one or two principles to which attention might be drawn in connexion with it. For instance, to take the case of a room lighted from the centre. One of the advantages was that a person could work in any part of the room and get a reasonable amount of light; but there was the disadvantage, if one were reading in such a room, that there would often be a reflection from the surface of the book or paper, and this, being a source of trouble to the eyes, caused a tendency to turn round away from the light. If a number of people in a room were all to do this, it would look a very unsociable gathering. Again, an advantage of lighting from the centre was that the furniture could be rearranged in the room much better than with bracket lighting. As a matter of fact, he personally objected to central lighting, agreeing with certain speakers that the horizontal illumination in a room should not be uniform, mainly for the reason that people usually wanted their rooms for comfort. If one were working or conversing, it was more pleasant to be able to look towards a dark corner of the room, thus resting the eyes, instead of always looking at a uniformly illuminated surface. He had been discussing this matter at different times for some years past with various friends, and had come to the conclusion that for pleasant lighting a considerable amount of variation throughout the room was desirable. If this view were accepted, then he thought we were forced to decide to illuminate our rooms from the walls; but if so, the position of both furniture and pictures must previously be settled, which was, as already referred to, a decided disadvantage. As an illustration, he quoted the case of a block of flats of which he knew, where a new tenant scarcely ever adopted the arrangement

FIG. 1.—Drawing-room lighted by gas, showing candle fittings (Mr. J. G. Clark).

FIG. 2.—Showing candle fittings in gas-lighted room (Mr. J. G. Clark).

of the lights which had satisfied the previous tenant. Halls and passages should not be lighted so brilliantly as rooms, because a feeling of depression was produced when one passed from a brilliantly lighted hall into a room with less illumination, which, although sufficient, would appear dull in comparison.

Mr. Leon Gaster referred to Mr Harrison's remarks on the personal taste of clients. He quite agreed that the lighting expert should, when consulted, defer to the consumer's wishes as far as possible, and it was frequently an important part of his duties to arbitrate between different members of the same household who held different views. At the same time he thought that if a consumer consulted an expert he would also be prepared to listen to his advice, and an illuminating engineer ought surely to use all his influence to prevent a client installing an arrangement which was clearly unsuitable. One reason why there might be laxity in this respect was that the principles of private house lighting had not yet been sufficiently discussed, and there were not yet sufficiently definite rules to guide the adviser and enable him to take a strong stand.

It was, however, evident, as Mr. Webber had mentioned, that for certain purposes—reading, sewing, &c.—a certain standard of illumination was necessary, and in such cases the suggestions made at meetings of the Society devoted to school and library lighting would presumably apply. As regards questions of taste, he thought that when a high standard was aimed at the need for competent expert advice was specially urgent. It was not every one who was gifted with artistic feeling, and many people were aware of this fact, and were quite willing to defer to the decision of the expert. Another matter on which much remained to be said was the effect of wall papers and the scheme of decoration on the illumination, and the choice of appropriate fittings. On such questions the conjoint efforts of the lighting engineer and the architect or decorative artist were really needed in order to secure the best possible results.

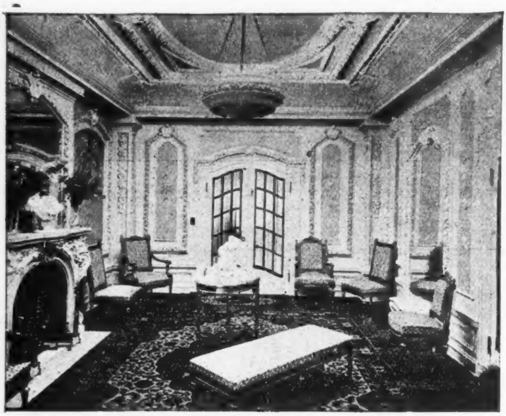

Fig. 3.—Indirect lighting in a drawing-room (Mr. Bush).

Mr. W. E. Bush (*communicated*).—One reason for the apparent contentment of the public with inefficient lighting methods lies in the fact that contractors do not take sufficient trouble to explain the advantages and principles of scientific illumination.

The majority of consumers are entirely ignorant of modern improvements, and base their requirements in regard to lighting equipment on family tradi-

tions or the advice of equally ignorant friends. The contractor, only too delighted at receiving an order, humbly takes instructions and does not attempt to point out the discomfort and wastefulness which are the result of unscreened or improperly equipped lamps.

Mr. Rawlings, in his paper, has almost entirely ignored all considerations of efficiency. The lighting fixtures illustrated on the slides which he exhibited were fitted with dense shades which must have been absorbing anything from 20 to 50 per cent of the horizontal candle-power, and the efficiency therefore on the plane of illumination must have been very poor indeed. For instance, six 100 c.-p. lamps for lighting a billiard table seemed to be very extravagant, and probably half that amount would suffice if efficient reflectors were used.

As a reply to Mr. Webber's criticism of indirect lighting, I would like to refer to two photographs (Figs. 3 and 4) illustrating residence lighting on the B.T.H. " Eye-Rest " system.

Apart from the beautiful, well-diffused light given by this system, the fittings, as will be seen from the photographs, are quite artistic in themselves, and conform to the general design of the interior in which they are placed.

The illumination given by this fixture in the small drawing-room is not by any means shadowless, so that there is no ground for Mr. Webber's complaint on that score.

Mr. Justus Eck (*communicated*).—Having had much experience in private house lighting, I fully realize the personal difficulties of dealing with the user of artificial light in what he feels is his impregnable castle; but, after all, the private citizen is under the influence of the sanitary as well as other laws in his home, and has to comply with the regulations of the gas, water, telephone, and electric authorities, and generally agrees with these. It is part of our duty as an Illuminating Engineering Society to see not only that the greatest efficiency is secured in the illuminant, but also that the illuminant is applied in the best possible way to produce good illumination and to ensure the protection of the user from any bad effects.

I had hoped at the meeting to have heard and seen more of suitable shades, refractors, reflectors, and fittings for domestic lighting. Mr. Darch's work has been referred to, and is quite in the right direction. Mr. Trotter's advice to have low specific brilliancy in the visible source, whether opal glass screen for a wall sconce or on wall or ceiling, must command our attention, even though, this being a matter of taste and not engineering, we may not agree with him in the desirability of

Fig. 4.—Indirect lighting in a sitting-room (Mr. Bush).

replacing wax candles by brass tubes, and prefer instead the present-day electric candle.

Indirect lighting for residences was hardly touched on, although, since the advent of the metal filament lamp, much progress has been made; and we have recently seen at our meetings, and also in the technical press, most excellent examples of club, board-room, and office lighting. I had recently to illuminate, in the cheapest possible manner, an assembly of oil-colour pictures in Bond Street, and found that, although for individual pictures designed reflectors and refractors gave all the good results claimed for them, that for an assembly, where individual lighting was impossible, indirect illumination from the white ceiling was ideal, and satisfied the three artists who undoubtedly were as difficult to please as any householder.

The degree of illumination is as important in private houses as elsewhere. The sudden demands on the eye and the development of artistic materials call for something very different from what was in vogue fifty years ago, and the engineer planning a house lighting installation needs data to give him the moral courage to force his points through with his clients. Such data and the facts on which they are based are the work of this Society, the application of them is a matter of individual tact, taste, and perseverance.

Mr. Rawlings makes a positive statement as to billiard-table lighting with which I cannot agree. Billiard matches are played in daylight with just the diffused light through a large skylight that indirect diffused lighting gives, and by night with indirect lighting from arc lamps, with great satisfaction.

Mr. Webber, at the conclusion of his paper, talks of the unsettling effects on him of shadowless illumination resulting from indirect lighting. I think he has omitted to remember that no known artificial illumination is shadowless. Diffused daylight is pleasant and restful, and produces useful and agreeable shade effects; diffused artificial lighting, properly designed, does the same.

Mr. W. R. Rawlings (*in reply*) said that Mr. Darch had been so fully answered by Mr. Trotter that he need reply to him no further. Mr. Trotter, like Mr. Webber, did not care for the imitation candle, but he would like to call attention to the fact that the finest fittings were French designs, which were originally designed for candles, and if one wished to use them, there was no other course open but to continue the imitation candles. Mr. Trotter's suggestion for dealing with candle fittings was a good one, as it would give the impression that the candle was somewhere below the screen. The colour of wall papers, of course, was of importance, but it was not a point over which the engineer had any control. It would be a great help if the lighting and the scheme of decoration could be decided conjointly, and he hoped the Society would take up this matter in the near future. Prof. Morris pointed out that the diversity factor of individuals must be taken into account. The fact that some individuals preferred standards or brackets, and others pendants, was a thing he experienced over and over again, and it showed how impossible it was as yet to lay down a golden rule for the illumination of any particular room. He had himself, on several occasions, when taking instructions for the lighting of houses met with many difficulties to which Mr. Haydn Harrison referred, and the difficulty was not easily overcome. The sort of thing that happened was this: the wife would tell him that he was not to mind what her husband said, she wanted brackets. A little while afterwards the husband would come along and tell him that he knew his wife did not like pendants, but he was going to have them. Such a circumstance, however, illustrated the need of independent advice, if necessary, in the capacity of arbitrator.

Mr. W. H. Y. Webber (*in reply*) also agreed as to the need for exercising tact in pleasing the consumer. The public, he said, did not yet understand anything about foot-candles. As long as lighting engineers had a guide in their minds as to what amount of light was

suitable for reading, writing, or working, he did not think it necessary to give everybody the details of their prescription. They had heard a good deal about " glare " ; but no one had said a word about one other important defect—spottiness (or extreme contrast). Was this included as a form of glare, or was it not ? In all questions of the effect of centre or side lighting, a great deal depended upon the background. It was almost a modern re-discovery, that if we put a white light against a white background glare was reduced ; but at the same time the measurable intensity was increased instead of being diminished, as in the case of shading with thick opal glass. The result was to destroy altogether the spotty effect ; and the more uniform brightness, in his experience, was far less likely to annoy the eye. These bright " candles " therefore ought to stand against a white, or nearly white, background. If they were going in for any bracket lighting, they ought, speaking generally, to have a reflecting surface behind ; but he still maintained that for the ordinary working-man's dining-sitting room, where this mode of lighting was not adopted, there should be fairly dark backgrounds. His own dining-room had quite a dark brown paper on the walls, which gave a restful and cosy impression ; while the white ceiling and deep white frieze gave good general distribution of the central light. He had no special reason for mentioning the different means of lighting the gas at a distance, beyond suggesting the convenience.

Good Light as an Asset.

MEASURING results in dollars and cents, scientific illumination is a valuable asset. It appears on the ledger as maximum office efficiency, with minimum office force ; maximum factory output, with minimum of " rejects " and " seconds " ; maximum satisfaction of customers, consumers, clients—every one to whom you furnish goods or service—with minimum of complaint and trouble ; maximum of health and comfort for yourself, your employees, your customers, with minimum of worry, annoyance, and expense ; maximum of light to use, with minimum of current to pay for.

The value of good illumination is not realized because it is so subtle. People feel it unconsciously. They avoid a store that is harshly or inadequately illuminated. They avoid harsh lighting just as they avoid noise. On the other hand, in a store where the illumination is quiet but effective they stay longer, do their shopping better and buy more without knowing why. They speak well of the store and visit it often.

The same thing applies to restaurants and other places where the comfort of customers is money in your pocket. It is even true of railroad stations and trains ; for public service corporations are becoming more and more alive to the money value of making their customers comfortable.

The cash value of good illumination in efficiency of employees cannot be overestimated. They work better and with les strain when they have just the kind of light and quantity of light suited to their work. Their eyes are better, their health is better, their heads are clearer. They don't get sick so often and stay away. The output is better, and there is more of it.

From 'Scientific Illumination,' issued by the Macbeth Evans Glass Co., Pittsburgh.

Annual General Meeting.

(Held at the House of the Royal Society of Arts, London, W C. on May 14th.)

MR. HAYDN T. HARRISON (Vice-Chairman of Council), who was in the chair, expressed regret at the absence of Mr. F. W. Goodenough, the Chairman, which was due to indisposition.

The minutes of the last meeting having been taken as read, the CHAIRMAN called upon the Hon. Secretary to read again the names of applicants for membership presented at the previous meeting, who were then formally declared members of the Society. The names of applicants for membership received since the last meeting were also read out for the first time.

THE CHAIRMAN said that, in accordance with the constitution, one-third of the Council resigned at the end of each year and offered themselves for re-election. Four members having expressed a desire to resign, and no new nominations from outside the Council having been received, the Council had nominated Dr. R. Lessing, Mr. W. R. Rawlings, Dr. H. R. B. Hickman, and Dr. A. H. Levy to fill the places, and, in the absence of other nominations, the existing officers of the Society had also been re-elected.

THE HON. SECRETARY then proceeded to read the Annual Report of the Council (see pp. 299 to 305).

MR. V. H. MACKINNEY then proposed "That the Report of the Council for the session November, 1911, to May, 1912, be formally adopted." He briefly alluded to the important and far-reaching work described in the Report. They had almost every day occasion to appreciate the services of those at the helm of the Society, and once a year they had the opportunity of giving expression to this appreciation when the Report of the year's activities was presented. One important and gratifying feature of the Report was the International situation, to which Mr. Gaster had made allusion. He did not think that too much stress could be laid upon the importance of this section of the work which had been carried out during the past session. The fact that they had the assistance of such distinguished Corresponding Members, showed that the Society was becoming a world-wide organization.

MR. W. J. LIBERTY, in seconding, said they might congratulate themselves as a Society—first, upon the breadth of the platform which they were building for themselves; and, secondly, with regard to the papers which they had had last session. As one who had been present at most of the meetings during the past session, he had very much pleasure in seconding the adoption of the Report. From whatever aspect they contemplated the now receding session, they might feel satisfied that the Society was rapidly becoming a large and important one.

THE CHAIRMAN, having remarked that the resolution for the adoption of the Report also involved the adoption of the Balance Sheet, put the proposal to the meeting, and it was declared carried unanimously.

MR. W. R. RAWLINGS then moved the following resolutions:—

"That Article 7 of the Constitution shall be modified to read as follows: The officers of the Society shall include a President, not less than 10 Vice-Presidents, an Honorary Secretary, an Honorary Treasurer, and the Council, of which the President, Secretary, and Treasurer shall be *ex officio* members."

"That Article 8 of the Constitution of the Society shall be modified as follows: The President shall hold office for one year only, and shall be eligible for re-election. The Vice-Presidents, Honorary Secretary, and Honorary Treasurer shall hold office for three years, and shall be eligible for re-election at the conclusion of their period of office."

MR. J. G. CLARK briefly seconded

these resolutions, and on being put to the meeting they were passed unanimously.

THE CHAIRMAN said he had a very pleasing and important statement to make. This had a bearing on the modification of Article 8, which had received very careful consideration. At their last meeting the Council, feeling that a special debt of gratitude was due to the President, had unanimously passed the following resolution, to which he invited their support :—

"That this Council records its cordial appreciation of the President's great services to the Society during the last three sessions. That in view of the important work awaiting the Society in connexion with the International Commission on Illumination, and in view of the fact that the Society now possessed an active Chairman able to officiate in the absence of the President, and to lessen the work involved in the supervision of the affairs of the Society, it is unanimously resolved to intimate to the President the Council's earnest desire that the Society should continue to profit by his guidance, and their unanimous resolve to invite him to continue in office."

As they all knew, Prof. Silvanus P. Thompson had been a most valuable help to the Society ever since he became the first President ; but, during the coming year, they particularly wanted him to serve again, because there was to be formed an International Commission on Illumination, at which the Society must be represented. Prof. Thompson, with his close knowledge of everything connected with the work of the Society, and his renowned facility as a linguist, would not only represent them in a way which no one else could do, but would give them at once a position among the Societies of the world. Under these conditions he was sure they would all agree with him in hoping that Prof. Silvanus P. Thompson would accept the Presidency for the fourth time.

Another resolution with which he thought they would all agree was the announcement that the Council had nominated Mr. A. P. Trotter one of their Vice-Presidents. Mr. Trotter was well known amongst them, and there was no need for any description of the work he had done, not only for the Society, but for illuminating engineering, even before the Society was formed. The paper which Mr. Trotter read before the Institution of Civil Engineers about nineteen years ago still remained one of the standard papers on illumination, in spite of the changes that had occurred in the various illuminants available, and he was sure they would agree with the Council that it would be a privilege to number him among their Vice-Presidents.

These proposals met with the hearty support of the meeting.

MR. W. J. LIBERTY then moved the following resolution :—

"That this meeting extends a cordial vote of thanks to the Council and officers for their efforts on behalf of the Society during the past session."

Those who were a little bit behind the scenes, and knew something of how things were managed, well knew the indefatigable efforts made by Prof. Silvanus P. Thompson, Mr. Goodenough, and Mr. Haydn Harrison and others, to say nothing of the untiring efforts of Mr. L. Gaster. He had much pleasure in moving his resolution.

MR. J. G. CLARK, in seconding, said there was no doubt that the good work which the Society was doing had been very largely due to the untiring efforts of the Council and officers.

The resolution was put to the meeting and carried with acclamation.

MR. LEON GASTER, on behalf of the Council, expressed thanks for the kind words of appreciation, and assured the meeting that what had been done had only been possible by the most friendly co-operation between the members of the Council.

DR. R. LESSING moved the following resolution, which was seconded by MR. E. A. NASH, and carried unanimously :—

"That this meeting extends a cordial vote of thanks to the Hon. Auditors of the Society for their services, and

that these gentlemen be requested to act in this capacity for another year."

THE CHAIRMAN next moved the following resolution.

" That this meeting desires to express a cordial vote of thanks to the Royal Society of Arts for the courteous permission to make use of the rooms during the past session, and to record its appreciation of the encouragement and support which the Society has received."

MR. R. J. WALLIS-JONES seconded, and expressed the wish that they would be allowed the use of the room so long as the Illuminating Engineering Society was able to use it—until, indeed, the coming time when their increase in membership of the Society led them to recognize that they had outgrown their first home.

The vote of thanks was carried with acclamation.

THE CHAIRMAN next called attention to the Appendix to the Report, which contained a list of subjects on which papers were invited for next session. The Council, he said, were most anxious to receive papers from those who had made a speciality of certain aspects of lighting. At the same time, the list was not intended to be exhaustive, and the Council were free to receive contributions on other subjects.

In concluding, THE CHAIRMAN said that Mr. Goodenough keenly regretted his unavoidable absence. He was sure that they had all appreciated the care and attention which Mr. Goodenough had given to the Society in his capacity as Chairman, and this appreciation was, perhaps, even greater on the part of the members of the Council, who had a closer opportunity of judging the skill which he had devoted to the affairs of the Society.

MR. LEON GASTER then alluded to his coming visit to the United States. Correspondence had passed with the Illuminating Engineering Society of America, and on more than one occasion a desire for closer co-operation had been expressed on both sides of the Atlantic. Circumstances had hitherto prevented his making a personal visit, but the great privilege and pleasing duty had now fallen to him of going to the States, carrying with him a message of goodwill from this Society. He felt sure they all recognized the unique pioneering work which the American Society had accomplished. With their permission, he hoped to be able to tell friends in the United States something of what had already been done in this country, and to exchange views as to how they could best use their joint efforts for furthering the illuminating engineering movement in the future.

MR. W. R. RAWLINGS proposed a vote of thanks to Mr. Haydn T. Harrison for presiding that evening, coupling with it the names of Mr. Gaster, the Hon. Secretary, and Mr. J. S. Dow, the Assistant Hon. Secretary. He thought the Society was indeed fortunate in receiving so much ungrudging honorary effort, and he personally had had several opportunities of appreciating the considerable amount of work which had been done.

Another instance of the work which was constantly being performed for the Society was afforded by Mr. Gaster's visit to the Continent and the States. It was a great advantage for the Society to be able to build up this international connexion by personal intercourse without committing itself to any corresponding financial outlay. So long as they had such representatives he was quite sure the Society must remain, as it already was, an eminently successful one.

MR. HAYDN T. HARRISON briefly responded to the vote of thanks. Speaking for himself, he said that it was the close interest that he took in the affairs of the Society which led him to attend the meetings whenever he could. Both at the Council meetings and the lectures he found he could learn something on every occasion, and he felt sure that they were all anxious to do their share towards making the Society powerful and respected.

Report of Council for the Session Nov., 1911 to May, 1912.

In accordance with the usual custom, the Council is issuing a Report of progress during the Session, which has been of a very satisfactory nature. During the past year the Society has been fortunate in extending its influence in many directions. Meetings have been devoted mainly to securing the co-operation of the general public, and many subjects of great interest have been discussed. A marked feature of the past session has also been the consolidation of the international position of the Society, which is now coming to be regarded as the European centre of information on matters connected with illumination. So many important incidents took place during the vacation that it was found necessary to issue a special report of progress at the opening meeting of the session.*

The development of public interest in illumination and the increased output of literature on the subject has again been most remarkable. It is particularly satisfactory to observe the direct interest taken by the daily press in the practical consequences of insufficient illumination. This has taken the form of frequent references to such matters as street lighting, the influence of illumination in mines on the eyesight of miners, the lighting of the House of Commons, &c.

Increased Membership and Support.

We have once more to report a steady growth in membership. The number of members now exceeds 340—an increase of seventy over the number at the corresponding period of last year—and the support of eminent authorities in various parts of the world, many of whom have taken a prominent part in other national and international commissions dealing with photometry and illumination, has been obtained. The Society has had the privilege of adding to its list of Vice-Presidents the names of Sir William Abney, D.Sc., F.R.S., C.B., Prof. A. E. Kennelly, and Prof. Elihu Thomson, and has also nominated its distinguished President (Prof. S. P. Thompson, D.Sc., F.R.S.) one of the Honorary Life Members for the present year. The Council has also had the pleasure of adding to its numbers three additional members: Mr. F. Bailey, Mr. A. W. Cortez Leigh, and Mr. E. Scott Snell.

It is interesting to observe that the various occupations and professions are represented in almost precisely the same proportions as during the previous year. The following figures serve to show the exceptional position enjoyed by the Society in providing an impartial platform for the discussion of problems connected with illumination :—

	Per Cent
Electrical Engineers and Members concerned mainly with Electric Lighting	32
Gas Engineers, Manufacturers of Gas Appliances, &c.	20
Professors of Physics and Engineering, Experts in Photometry, &c.	14
Representatives of Oil, Acetylene, Petrol Air Gas Lighting, &c.	6
Physicians, Oculists, Opticians, &c.	10
Architects, Surveyors, &c.	5
Miscellaneous, including Public Lighting Superintendents, Mechanical Engineers, Makers of Shades and Reflectors, and others not exclusively connected with any one system of lighting	13
	100

Meetings of the Society during the Past Year.

During the past year six meetings (not including the Annual General Meeting) have been held.

On November 17th, 1911, a paper was read by Dr. H. R. B. Hickman entitled 'Notes on the Design of Motor-car Headlights,'* the subject being

* *Illum. Eng.*, Lond., Dec., 1911, p. 684.

* *Illum. Eng.*, Lond., Dec., 1911, p. 687.

specially suitable in view of the Motor-car Exhibition at Olympia taking place about the same date. Invitations were issued to the Royal Automobile Club and to other associations interested to take part in the discussion, and representatives of many well-known firms manufacturing motor-car headlights were present at the meeting. The opportunity was also taken of drawing the attention of the traffic officials representing the City and Metropolitan Police to the work of the Society and of pointing out the importance of more precise regulations on the brightness and arrangement of headlights, and in connexion with street lighting.

At the second meeting, on December 19th, Mr. Haydn T. Harrison read a paper on the subject of 'Railway and Goods Yard Illumination.'* Engineers connected with many of the most important railways were present, and joined in the discussion, and it is hoped that the information brought forward at this meeting will be of assistance in ultimately determining some standards of the illumination required.

The third paper of the Session, on January 16th, 1912, by Mr. T. E. Ritchie,† dealt with 'Colour Discrimination by Artificial Light.' Invitations were issued to many people whose occupation led them to be interested in this matter, including artists, dyers, colour printers, carpet manufacturers, &c.

During the remainder of the Session three practical applications of illumination were taken up, two distinct papers, dealing with the subjects from the standpoint of gas and electric lighting respectively, being presented on each evening. On February 20th Mr. N. W. Prangnell presented a paper on 'Shop Lighting by Electricity,' Mr. A. E. Broadberry reading the corresponding paper on 'Shop Lighting by Gas,'‡ and the importance of this subject was brought home to many representatives of large London stores present.

On March 19th Mr. F. W. Goodenough dealt with 'The Lighting of Printing Works by Gas,' and Mr. Justus Eck with 'The Lighting of Printing Works by Electricity.'* Valuable data collected as the result of observations in the works of important London daily newspapers and printing firms were presented, and invitations to a large number of journals and printing establishments were sent out. The presence of representatives of the Master Printers' Association, the London Society of Compositors, the Institute of Printers, and other Associations was also invited, and the Society was thus instrumental in impressing the need of good illumination on yet another section of the public.

* *Illum. Eng.*, Lond., Jan., 1912, p. 25.

† *Illum. Eng.*, Lond., Feb., 1912, p. 64.

‡ *Illum. Eng.*, Lond., March, 1912, pp. 125-151.

The concluding papers of the Session, by Mr. W. R. Rawlings and Mr. W. H. Y. Webber, dealt respectively with Private House Lighting by Electricity and Gas respectively. It will be seen, therefore, that during this Session the Society has been signally successful in acting as a link between the general public and the technical lighting expert, and it has been able to stimulate an interest in illumination in many different quarters. The data collected in these papers will also doubtless be of great value for future reference.

The Society has also realized its ambition of receiving on the same platform and on the same evening papers from representatives of gas and electric lighting, and conducting friendly and impartial discussions. The thanks of the Society are due to the authors of these papers, which invariably gave rise to most interesting meetings.

The Annual Dinner.

The Annual Dinner of the Society took place on February 15th, the President, Prof. S. P. Thompson, D.Sc., F.R.S., being in the chair, and many members and friends were present. The proceedings were most enjoyable, and the speeches and representative character of the gathering worthily upheld the traditions of the Society.

After the loyal toasts had been duly honoured, Prof. R. S. Clay, Principal of the Northern Polytechnic, proposed

* *Illum. Eng.*, Lond., April, 1912, pp. 171-200.

the toast of "The Illuminating Engineering Society," dwelling upon the important international position which it now occupied. The President, in replying to the toast, devoted himself to a convincing summary of the important work now being undertaken.

The toast of "Kindred Societies" was proposed by Mr. F. W. Goodenough (Chairman of Council), and replied to by Mr. R. G. Shadbolt (President of the Institution of Gas Engineers) and Mr. W. M. Mordey (Past-President of the Institution of Electrical Engineers), who pointed out the valuable common platform provided by the Society, the functions of which could not be performed by any other existing body.

Mr. R. J. Wallis-Jones proposed the toast of "Our Guests." The toast was responded to by Dr. W. Garnett, Educational Adviser to the London County Council, and Dr. F. G. Kenyon, Chief Librarian at the British Museum, both of whom referred in warm terms to the aims of the Illuminating Engineering Society, and to the excellent results it had already accomplished in drawing attention to the importance of school and library lighting.

The proceedings concluded by a vote of thanks to the Chairman and President, proposed by Mr. L. Gaster (Hon. Secretary), which was received with enthusiasm.

Special Committees on Street, School, and LibraryLighting.

The Joint Committee—on which representatives of the Institutions of Gas and Electrical Engineers, the Association of County and Municipal Engineers, and the Illuminating Engineering Society are nominated—is still engaged on its task of preparing a draft specification for street lighting. A considerable number of meetings have been held, and much valuable data collected, and it is anticipated that its findings will be available shortly. It may also be mentioned that during the summer vacation last year several articles appeared in *The Illuminating Engineer*,* containing the presentation, in tabular form, of the results of inquiries addressed to a number of corresponding members on the Continent and in the United States.

As explained in the Report presented at the commencement of the Session,* the Joint Committees on School and Library Lighting, decided upon at the conclusion of the discussions of the Society on these subjects at the commencement of last year, have now been constituted. Representatives of the Library Association, the Association of Medical Officers in Schools, the Association of Technical Institutions, the Association of Teachers in Technical Institutions, and the London Teachers' Association have been appointed, and are taking part in the proceedings. Several meetings have already been held, and the Committees are preparing some suggestions which, it is hoped, will prove of considerable use to those concerned with the lighting of schools and libraries. In addition, it is proposed that these Committees will act as a permanent centre for information on these subjects.

The International Commission on Illumination.

One of the most important events during the past year, the decision taken at the International Electrical Congress in Turin last September, has already been referred to in the Report of Progress during the Vacation. It will be recalled that the Congress unanimously passed the following resolution at the plenary meeting on September 16th, 1911 :—

That this Congress deems it desirable that an International Commission should be appointed in order to study all systems of lighting and technical problems in connection therewith ; and, having been informed that the Illuminating Engineering Society of London has the intention of forming such a Commission and of putting itself in touch with the other existing national and international photometric committees, approves their taking the initiative in this respect.

A resolution was also passed unanimously by the Electrotechnical Commission affirming *that the National*

* *Illum. Eng.*, Lond., vol. iv., May and July, 1911.

* *Illum. Eng.*, Lond., Dec., 1911, p. 684.

Committees should co-operate with the Illuminating Engineering Societies in their respective countries in studying the question of symbols, nomenclature, and other matters relating to illumination; and this resolution received the cordial support of Dr. A. E. Kennelly and Dr. C. H. Sharp (respectively President and Past-President of the American Illuminating Engineering Society).

The Hon. Secretary—who was present at these meetings in Turin—also read a paper on 'The International Outlook in Scientific Illumination,' in which he demonstrated the value of such an international Commission on Illumination. It was pointed out that, although valuable pioneering work had been carried out by the existing national and international committees concerned with illumination and photometry, these committees lacked the necessary impartial and international standing for their decisions to be received with the necessary authority in different countries and by representatives of different illuminants; moreover, what was desired was a Commission which, besides dealing with purely photometric matters, would have power to deal with certain questions of great practical importance (such as the hygienic aspects of illumination, the framing of standards regarding the illumination required for various purposes, &c.).

In receiving the sanction of the International Electrical Congress to form such a Commission, the Society has been afforded a most gratifying recognition of the impartial and international position. It will naturally be desirable to arrange for due representation on the suggested Commission of existing bodies dealing with various aspects of illumination. In this respect the Society is in an exceptionally fortunate position, since it now includes among its members delegates on all the chief commissions of this kind. For example, during the vacation a number of delegates to the International Photometric Commission and the International Electrotechnical Commission gave their support by becoming corresponding members. It need scarcely be added that in this work the co-operation of the American Illuminating Engineering Society, many of whose members are also supporters of our Society, will be very valuable.

By this resolution, it will be observed, the support from the electrical industry throughout the world has been secured, and it is hoped to obtain similar international encouragement from the gas industry.

The Hygienic Aspects of Illumination and the Prevention of Industrial Accidents.

As an additional example of the activity of the Society during the last summer vacation, it may be mentioned that the International Hygienic Exhibition at Dresden was visited by Mr. Justus Eck and Dr. R. Lessing, and the Society was also represented locally by Drs. Schanz and Stockhausen and by Prof. Ulbricht. A series of exhibits dealing with illumination were also dispatched to the Exhibition, including various photographs, taken by artificial light and showing the illumination of schools and factories by gas and electricity, which were much appreciated.

At the Annual Congress of the Royal Sanitary Institute the Hon. Secretary and Mr. J. Darch were present, and the latter read a paper on the subject of 'Hospital Lighting.' The President and Mr. J. Eck were also nominated as delegates of the Society, but were unavoidably prevented from being present.

It may also be mentioned that a paper read by Mr. W. H. Webb on this occasion contained some notes on School Lighting. It was gratifying to observe that the suggestions on this subject resulting from the meetings of the Society earlier in the year were specially recommended to the notice of school officers. This illustrates the manner in which the influence of the Society is gradually making itself felt, and it may be hoped that its recommendations will continue to receive support by the authorities concerned.

The question of the hygienic aspects of lighting in factories continues to receive attention in this country. It is understood that the Home Office are

making arrangements for tests of the illumination in various factories, to be undertaken with a view to establishing ultimately some form of standard. It will be recalled that the Report issued by the Departmental Committee on Accidents in Factories, issued just before the termination of the last Session, contained specific reference to illumination, it being pointed out that "inadequate lighting is a very frequent cause of accident and of grave danger." It is also recommended that "inspectors should be given general statutory power to require adequate lighting in all places where work is done and in all places which are a source of danger by reason of insufficient lighting." Since the publication of this report the complete evidence of the various witnesses has been issued, and contains many instructive instances of poor conditions of lighting having led to more or less serious accidents.*

It will also be remembered that in the last Report of the Council stress was laid on the important position assigned to illumination in the deliberations of the second Congrès International des Maladies Professionelles in Brussels last year. Special reference was then made to the need for effective lighting of dangerous machinery.

The precedent set on this occasion has now been followed by the announcement of a Congress on the Prevention of Industrial Accidents, to be held in Milan at the end of May. The Society will be represented by its Hon. Secretary, Mr. L. Gaster, who has been invited to read a paper on 'The Value of Good Illumination from the Hygienic Standpoint and as a Means of Preventing Accidents.' It is hoped that this Congress will be the means of still further interesting insurance and other authorities, and also the representatives of the Governments of various countries in these matters.

An exceedingly important step has also been taken by the French Government in appointing a Committee on the Hygienic Aspects of Illumination. On this Committee prominent oculists and physiologists, engineers and factory inspectors, will serve, and it will discuss many matters of considerable industrial importance (such as the framing of standards of illumination, and of simple lighting rules for use in factories and workshops, the nature of defects of vision and their relation to unsatisfactory lighting conditions, methods of measuring illumination, &c.). The Hon. Secretary, in the course of his visit to the Continent, took the opportunity of interviewing some of the experts on this Committee and the representatives of various Government departments interested in the subject, and it is hoped that the action taken by France will shortly be followed in other countries. The experience of authorities in different countries is needed in these matters, in order that general recommendations which will be acceptable throughout the world may ultimately be made, and also with a view to avoiding any errors which might naturally arise in physiological investigations conducted only on a few individuals.

It may also be mentioned that the conditions of illumination in factories and workshops has been the subject of much consideration in the United States. As an example we may mention the formation of the National Association for the Conservation of Eyesight, which will doubtless aid the good work in this direction already being done by the American Illuminating Engineering Society. The National Association for the Conservation of Vision has been issuing periodical bulletins summarizing the work so far carried out, and there are several other publications in the United States, such as *The Journal of Industrial Safety*, which habitually refer to the need of good illumination in the factory and workshop.

Education in Illuminating Engineering.

In the last Report of the Council attention was called to the special post-graduate course of thirty-six lectures organized by the Johns Hopkins University of Baltimore, U.S.A., in the autumn of 1910. Various branches of illuminating engineering were dealt with, the lectures in each case being

* *Illum. Eng.*, Lond., March, 1911, p. 193; June, 1911, p. 401.

delivered by eminent authorities in their respective subjects. In referring to this unique series of lectures, the hope was expressed that courses in illuminating engineering would shortly be arranged in this country.

This anticipation has been realized. During the last winter four distinct courses of lectures were delivered at University College, Regent Street Polytechnic, the Northampton Institute, and Battersea Polytechnic. The course at University College, by Prof. W. C. Clinton, was of an advanced character. The other three courses were more general and popular in their scope, and were delivered by specialists in their respective fields. It may be added that, almost without exception, the lecturers were members of this Society. It is estimated that over 100 students attended these courses. This may be considered a most gratifying beginning, and it is hoped that ultimately courses in illuminating engineering will form a regular feature of the programmes of the chief colleges and institutions.

The Title of "Illuminating Engineer."

The three years that have elapsed since the formation of the Society have given a great impetus to the illuminating engineering movement, and have stimulated a demand for expert advice on illumination. From the commencement it has, however, been agreed that the use of the title "illuminating engineer" by consulting experts on lighting should be deprecated, and membership in the Society is not at present regarded as entitling members so to describe themselves. Until a body of men who have the necessary qualifications and experience to deal impartially with all illuminants and with the various aspects of lighting included under the term "illuminating engineering" has been evolved, the use of the term "illuminating engineer" should be avoided. At a later date it is hoped that it will be possible to define more precisely what the qualifications of an illuminating engineer should be, and this matter will then receive the attention of the Society.

Financial Position of the Society.

The balance sheet, showing the income and expenditure of the Society up to the end of 1911, is appended. It will be seen that the Society, in spite of its limited membership, has been able to carry out a considerable amount of useful work and yet to keep its expenditure within bounds.

As explained in the Report for 1910–11, the fact of its having been found possible to do so is mainly due to the very satisfactory arrangement made with the Illuminating Engineering Publishing Co., Ltd., that *The Illuminating Engineer* (published in London) should be the official organ of the Society; otherwise the cost of publishing and circulating the transactions of the Society, estimated at £350, would have been prohibitive with its present membership and subscription.

The established international connexion of the journal has already been of great benefit, and will be of even greater service now that a prospect of important international work is opening before the Society. The fact of *The Illuminating Engineer* being a monthly journal has also been much appreciated by members since it has enabled the prompt publication of papers and discussions, and has also been of service in announcing forthcoming events.

The Society has also been exceptionally fortunate in not being called upon to meet many customary expenses, such as rent for offices, secretary's salary, &c., and a debt of gratitude is due to its officers, who, in an honorary capacity, have ungrudgingly devoted much time to its affairs.

It is satisfactory to observe that the increased number of members and subscriptions will no doubt render the position of the Society easier financially in course of time, but it is pointed out with regret that a considerable number of subscriptions are in arrear, and it is hoped that members will help the Society by paying in their subscriptions as promptly as possible in the future, as well as clearing off present deficiencies.

PROGRAMME FOR THE NEXT SESSION.

During the next Session the various Committees of the Society will continue their activities, and it is hoped that reports of some of their proceedings will shortly be available.

The Council is now engaged in considering the programme for the next Session. Members who are willing to read papers are invited to notify the Hon. Secretary as soon as possible, and to send in contributions early in the vacation. A list of suitable subjects (which, however, is issued as a suggestion only, and is not exhaustive) will be found in the appendix (p. 306).

During the first Session it was deemed desirable to deal mainly with principles, and subsequently a natural transition was made to several applications, such as the illumination of schools, libraries, shops, &c. It is hoped in the future, as increased membership and improved acquaintance with the principles of illumination justifies this course, that it will be possible to enter more fully into details and to devote attention to specific technical problems in lighting.

The Council, while appreciating the generous support they have received in former years, desire again to impress on members the desirability of interesting others in the work of the Society and securing a further numerical addition to its membership. The preliminary stages of the Society's work are passed, and it is now entering upon a most important phase of its existence. It is, therefore, essential to leave no stone unturned to secure its continued success.

By Order of the Council,

LEON GASTER,

Hon. Secretary.

Lamps as Time-Limit to Speakers.

WHEN, a few years ago, Parliament became a recognized institution in Russia, the question of the length of speeches early engaged the attention of the framers of the new adjunct to an ancient Constitution. It was agreed that fifteen minutes was a reasonable allowance per head, and an ingenious contrivance was introduced with design to mark off the allocation. On each man's desk was fixed a red lamp fed by electricity. When the member rose to speak, the lamp lit up. At the end of a quarter of an hour it automatically went out, and simultaneously the orator, even if he were in the middle of a sentence, shut up.—*The Observer*, Sunday, May 5th, 1912.

The Value of School Lighting.

IN his first report on the inspection of Breconshire children Dr. J. C. Bridge, says there can be little doubt that school life is productive of visual defects.

"The importance of proper lighting in schools cannot be over-estimated. Not only is efficient lighting important in producing a healthy condition of the mind and improving the mental faculties of the children, but, also, improper lighting is undoubtedly one of the many factors in the production of visual defects. It cannot be too strongly urged that efficient lighting implies not only sufficient light, but light of the right amount and from the right direction."—*The Medical Officer*, May 11th, 1912.

REPORT OF COUNCIL.

APPENDIX.

List of Suggested Subjects on which Papers are invited.

1. New developments and novel applications of gas and electric lighting.
2. General progress in (*a*) acetylene lighting, (*b*) incandescent, oil, paraffin, and petrol air gas lighting.
3. The nomenclature and terminology of illuminating engineering.
4. New forms of instruments for measuring light and illumination and new apparatus for use in the photometrical laboratory. Methods of testing colour. Methods of testing the steadiness of sources of light.
5. The design and functions of shades and reflectors and their value in interior and outdoor lighting.
6. Fixture design: the compromise between artistic and illuminating principles.
7. The measurement of daylight and its application by the architect to designing window-space, and the access of natural light to interiors. The value of photometry in deciding ancient light cases.
8. What constitutes good street lighting?
9. Decorative lighting and illuminating engineering from the standpoint of artistic effect and architectural principles.
10. Simple methods of calculating beforehand the distribution and intensity of illumination in interiors.
11. Instruction in illuminating engineering: Courses of lectures and laboratory work, &c.
12. The benefits of good illumination from the insurance standpoint, and as a means of preventing accidents.
13. The value of good illumination in factories and workshops from the hygienic and sanitary standpoint.
14. Illumination Portable safety lamps for mines, &c.
15. Modern methods of lighting and illuminants employed in ships, light houses, buoys, coast-lights, beacons, &c.
16. The use of light for advertising purposes, illuminated signs and devices, illuminated placards, billboards, notices, &c.
17. The production of light of various colours, and the best means of modifying the spectra of artificial illuminants so as to resemble that of daylight.
18. Problems encountered in the lighting of museums, picture galleries, &c.
19. The decorative lighting of parks, avenues, and flower gardens, fêtes, &c.
20. The physiological aspects of illumination, and the effects of artificial light on the eyes.
21. The correct application of light in projection, searchlights, lanterns, cinematographs, &c.
22. The relative advantages of direct and indirect illumination, the best means of combining the systems, and the occasions on which either method, or a combination of both, is most suitable.
23. The lighting of billiard tables.
24. The artificial illumination of athletic grounds, tennis courts, skating rink, bowling alleys, &c.
25. Country house lighting by private electrical installations, by acetylene, or by petrol air gas and incandescent oil vapour.
26. Theatre lighting: illumination on the stage and its use to produce scenic effects, &c.

The Illuminating Engineering Society.

(FOUNDED IN LONDON, 1909.)

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In recognition of valuable services in connexion with electric lighting, and as one of the inventors of electrical incandescent lamps.

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In recognition of valuable services as President of the Congrès International des Maladies Professionnelles, Brussels, 1910.

Thompson, Prof. Silvanus P., *D.Sc., F.R.S.* Past President of the Inst. of Electrical Engineers, Professor of Electrical Engineering and Principal of the City and Guilds of London Technical College, Finsbury, E.C., "Morland," Chislett Road, West Hampstead, London, N.W.

In recognition of valuable services as President of the Illuminating Engineering Society during its first two years of existence.

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LIST OF MEMBERS OF ALL CLASSES (May, 1912).

[*The figure at the end of the address denotes the quarter day upon which the subscription becomes due. Thus* (1) *denotes Jan.* 1st; (2) *April* 1st; (3) *July* 1st, *and* (4) *Oct.* 1st *respectively.*]

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C.M.	Monasch, Dr. B.	Superintending Engineer of the Wolfram Lamp Co., Ltd., Augsburg, Member of the Photometrical Commission of the Verband Deutscher Elektrotechniker, 1903, 3, Lampestrasse, LEIPZIG.
	Mond, Dr. E. S. *F.C.S.*	Chemical Manufacturer, 22, Hyde Park Square, LONDON, W. (1).
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	Morris, Prof. J. T. *M.I.E.E.*	Professor of Electrical Engineering at the East London College, 47, Cumberland Mansions, Seymour Place, LONDON, W. (1).
	Mygatt, O. A.	Director of Holophane Ltd., 12, Carteret Street, Westminster, LONDON (1).
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	Newton, E. B. B.	Civil Engineer and Borough Surveyor of Paddington, Town Hall, Paddington, LONDON, W. (1).
	Nicholls, M. E.	Chief Indoor Inspector of the South Met. Gas Co., 709, Old Kent Road, LONDON, S.E. (2).
	Norden, J.	Manufacturer of Incandescent Mantles, Fittings, &c., 44, Farringdon Street, LONDON, E.C. (1).
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C.M.	Ott, Dr. E.	Chemist to the Zurich Gas Works; Member of Int. Photometric Commission, Schlieren, ZURICH, Switzerland.
C.M.	Owens, H. Thurston.	Engineer and Lighting Expert, 13–21, Park Row, NEW YORK, U.S.A.
C,M.	Oya, A.	Member of Int. Electrotechnical Commission; Elec. Engineer, of the Imperial Electrotechnical Laboratory, Ministry of Communications, TOKYO, Japan.
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V.P.	**Parsons, Dr. J. H.** *F.R.C.S., &c.*	Ophthalmic Surgeon, Lecturer at University College, &c. 54, Queen Anne St., Cavendish Square, LONDON, W.
	Paterson, C. C. *M.I.E.E.* *A.M.I.C.E.*	In Charge of Electrotechnical and Photometrical Dept. of the National Physical Laboratory, Bushy House, TEDDINGTON, England (1).
M.C.	PEARCE, S. L. *M.I.C.E., M.I.E.E.*	Chief Electrical Engineer to the Manchester Corporation, Dickinson Street, MANCHESTER (Past Pres. of the Incorporated Municipal Electrical Assocn.). (1)
	Peronne, P. E.	Superintendent, Photometer Department, Osram Lamp Works, 12, Moore Park Road, Fulham LONDON, S.W. (4)
	Peschke, Max	Manager Holophane, G.m.b.H., 35, Dorotheenzstrasse, BERLIN N.W.7 (2).
C.M.	Picou, R. V.	Civil Engineer; President of the French Electrotechnical Committee, 41, Rue Saint Ferdinand, PARIS.
	Plumtree, J. S. *A.M.I.E.E.*	Electrical Engineer to the Union Electric Co., 23, Grasmere Road, Muswell Hill, LONDON, N. (1).
	Prangnell, N. W. *A.M.I.E.E.*	Electrical Engineer, Distributing Engineer, Metropolitan Electric Supply Co., 16, Stratford Place, LONDON, W. (1)

Hon. Member, V.P.	**Preece, Sir Wm.** *K.C.B., F.R.S., &c.*	Consulting Electrical Engineer, Past President of the Institutions of Electrical and Civil Engineers, Gothic Lodge, Wimbledon, LONDON.
M.C.	RAWLINGS, W. R.	Electrical Contracting Engineer, Past President of the Electrical Contractors' Association, 82, Gloucester Road, South Kensington, S.W. (1).
	Recklinghausen, Dr. M. von.	Managing Director, Westinghouse Cooper Hewitt Co., 73, Boulevard Haussmann, PARIS (4).
	Redgment, G.	Electrical Engineer, 5, Bank Plain, Norwich (1).
V.P.	**Redwood, Sir B.** *D.Sc., F.R.S.E., F.I.C.*	Consulting Chemist and Adviser on Petroleum to the Home Office, 4, Bishopsgate Street Within, LONDON, E.C.
	Reilly, E. P.	Civil Engineer, Chief Engineer and Manager of the Cape Town and District Gas Company (4).
	Reiner, J. B.	Optician, 9, Vere St., Cavendish Square, LONDON. (2).
	Reiter, Dr. C.	Chief Chemist of the Imperial Lamp Works, 17, Osborne Road, Brimsdown, MIDDLESEX (4).
	Richardson, A. H.	Engineer, Tottenham, and Edmonton Gas Co., 51, Queen's Avenue, Winchmore Hill, London, N. (1)
	Richtmyer, Prof. F. K.	Instructor of Physics, Cornell University, 108, Linden Avenue, ITHACA, N.Y., U.S.A. (2).
	Rissel, A. K. W.	Electrician, late of Public Works Dept. of New Zealand, Canada Ford Company, 485, St. James's Street, MONTREAL, CANADA (1).
	Ritchie, T. E. *A.M.I.E.E., A.M.I.M.E.*	Chief Departmental Engineer, Lamp Dept., Union Electric Co., 20, Kingston Lane, TEDDINGTON (2).
C.M.	Rosemberg, R.	Editor of the *Revue des Eclairages*, 104, Boulevard de Clichy, PARIS.
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	Scholtz, Max	Director of Messrs. Ehrich & Graetz, S.O. 36, Elsen Strasse 92/94, BERLIN (1).
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	Schwabacher, Dr.	Engineering Chemist to the Machine Petrol Air Gas Syndicate, Ltd., Connaught Club, Marble Arch, LONDON, W. (1).
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	Sheppard, E. G. *A.M.I.E.E.*	Works Manager, Robertson Electric Lamp Co., 18, Bridge Avenue Mansions, Hammersmith, LONDON, W. (1).
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	Solomon, M. *A.M.I.E.E.*	Manager of the General Electric Company's Carbon Works, Witton, Birmingham, Bradley, Grange Lane, Erdington, BIRMINGHAM (1).
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C.M.	Terneden, Dr. L. J.	Member of Int. Photometric Commission; Engineer to the Corporation Gas Works, AMSTERDAM.
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Hon. Member. President	**Thompson, Prof. Silvanus P.** *D.Sc., F.R.S.*	Past President of the Inst. of Electrical Engineers, Professor of Electrical Engineering and Principal of the City and Guilds of London Technical College, Finsbury, E.C., "Morland," Chislett Road, West Hampstead, London, N.W.
	Thomson, Alex., Jr.	Electrical Engineer to the Union Electric Co., 8, Hamilton Park Terrace, Hillhead, Glasgow (2).
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	Thomson, T. G.	57, Haselrigge Road, Clapham, London, S.W. (1).
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	Topley, W. W. *Mem. Inst. Gas Engrs.*	Secretary of the Croydon Gas Co., Katherine Street, Croydon, England (1).
	Trewby, L. *Mem. Inst. Gas Engrs.*	Gas Engineer, Gas Works, Mill Hill, London, N.W. (1).
V.P.	**A. P. Trotter,** *M.I.E.E.*	Electrical Adviser to the Board of Trade, 8, Richmond Terrace, Whitehall, London, S.W. (1).
V.P., C.M.	**Ubbelohde, Prof.**	Gen. Secretary of the International Petroleum Commission, Karlsruhe, Germany.
V.P., C. M.	**Ulbricht, Prof.**	President of the Königl. Generaldirektion der Sächsischen Staatsbahnen, Member of the Photometrical Commission of the Verband Deutscher Elektrotechniker, Hettner Str. 3, Dresden.
	Venner, R. F.	Electrical Engineer, 6, Old Queen Street, Westminster, London, S.W. (1).
Hon. Member.	Vernon Harcourt, Prof. A. G. *M.A., F.R.S.*	Past President of the Chemical Society, Metropolitan Gas Referee, &c., St. Clare, Ryde, Isle of Wight.
C.M.	Verstraeten, Th.	Member of Int. Photometric Commission; President of the Compagnie Generale du Gaz, 34, Rue Marie de Burgoyne, Brussels.
V.P. C.M.	**Violle, Prof. J.**	89, Boulevard St. Michel, Paris.
C.M.	Voege, Dr. W.	Asst. in the Physikalische Staatslaboratorium Hamburg, Member of the Photometrical Commission of the Verband Deutscher Elektrotechniker (1909), Tierischstrasse 170/1, Hamburg, Germany.
M.C.	Waldram, P. J. *F.S.I.*	Surveyor, Civil Engineer, 12, Buckingham Street, Charing Cross, London, W.C. (1).
	Walker, F. J.	Managing Director, St. James's and Pall Mall Electric Supply Co., 19, Carnaby Street, Golden Square, W. (1)
	Walker, H.	Surveyor to the Law Union and Rock Insurance Co., 126, Chancery Lane, London, E.C. (1).
M.C.	Wallis-Jones, R. J. *M.I.C.E., M.I.E.E.*	Consulting Electrical Engineer, 50, Queen Anne's Gate, Westminster, London, S.W. (1).
	Walmesley, Prof. R. M. *D.Sc.., F.R.S.E.*	Principal of the Northampton Institute, 28, St. John Street, London, E.C. (1).
	Walters, E. H.	Engineer-in-Chief's Office, G.P.O., London, E.C. (4).
	Webber, W. H. Y.	Gas Engineer, Staff Instructor to the Gas Light and Coke Co., Isca, Udney Park, Teddington (1).
V.P., C.M.	**Weber, Prof. L.** *Ph.D.*	Professor of Physics at the University of Kiel, Moltkerstr. 60, Kiel, Germany.
V.P.	**Wedding, Prof. Dr. W.**	Professor at the Technische Hochschule, Charlottenburg, Gross Lichterfelde, Wilhelmstrasse, 2, Berlin.
	Weekes, R. W. *M.I.E.E.*	Consulting Engineer, Maxwell House, Arundel Street, Strand, London, W.C. (2).
C.M.	Weinbeer, E. W.	Electrical Engineer and Professor of Electrotechnics at Charlottenburg, 4 Röntgenstr, Charlottenburg, Germany.

	Weston, G. C. *A.M.I.E.E.*	Distribution Engineer to Kensington and Knightsbridge Electric Lighting Co., Prince Consort Road South Kensington, LONDON, W. (1).
	Wheat, H. C.	Electrical Engineer, 9, Moat Street, RUGBY (1).
	Wild, L. *M.I.E.E.*	Director of the Westminster Electrical Testing Laboratory, York Mansions, York St., LONDON, S.W. (1).
	Willcox, F. W.	The British Thomson-Houston Co., Mazda House, 77, Upper Thames Street, LONDON, E.C. (4).
	Williams, J.	General Manager of the Foreign and Colonial Lighting Co., Ltd., Emberton Lodge, NEWPORT PAGNELL, England (1).
	Williams, W. H. *A.M.I.E.E.*	Manager of Lamp Dept. of the Electrical Co., 115, Lower Richmond Road, East Sheen, London, S.W. (1).
	Wilson, C.	Electrical Engineer, 80, Castlenau, Barnes, London, S.W. (1).
	Wilson, D. R.	H.M. Inspector of Factories, Home Office, Whitehall, LONDON, S.W. (4).
	Wingate, M. F.	Optician, 35A, Welbeck Street, London, W.
	Wohlauer, A. A.	Consulting Electrical Engineer and Lighting and Heating Expert, 546, Fifth Avenue, NEW YORK, U.S.A. (1).
V.P.	**Wood, Sir Henry Trueman.**	Secretary of the Royal Society of Arts, John Street, Adelphi, LONDON.
C.M.	Wrightington, E. N.	Vice-President of the Boston Consolidated Gas Co., 24, West Street, BOSTON, Mass, U.S.A.

NEW MEMBERS OF THE SOCIETY.

The names of the applicants for membership, read out at the previous meeting on April 16th, were formally announced for the second time, and these gentlemen were declared Members of the Illuminating Engineering Society.*

In addition the names of the following gentlemen have been duly submitted and approved by the Council, and were read out by the Hon. Secretary at the annual meeting of the Society on May 14th.

Bond, H. I.	Lighting Engineer to the London & South Western Railway, Engineer's Office, Waterloo Station, London, S.E. (2).
Girdleston, H.	Lighting Engineer to the British Thomson-Houston Co., Ltd., 41, Church Street, Sheffield. (2)
Lynch, A. *M.P., L.R.C.P., &c.*	Civil Engineer, Member of the London Mathematical Society, &c., House of Commons, Westminster. (2)
Rayment, A. J.	2, White Hart Street, Paternoster Square, E.C. (2)
Taylor, A. L. *M.I.E.E.*	Chief Electrical Engineer to the Liverpool and London and Globe Insurance Co., Ltd., The Tithebarn, Great Crosby, Liverpool (2).

* *Illum. Eng.*, Lond., May, 1912, p. 235.

In addition the following names have since been received, and will be submitted at the next Council meeting:—

Ellworthy, Dr. H. S., F.R.C.S.	Inspector of injured workmen, Ebbw Vale, Steel, Iron, and Coal Co., Monmouthshire.
Jacoby, H. A.	11, Queen Victoria Street, London, E.C.
Krupka, O.	11, Queen Victoria Street, London, E.C.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Benjamin Reflector Fittings.

These fittings, made by the **Benjamin Electric, Ltd.** (117, Victoria Street, London, S.W.), are designed to meet the demand for a durable, high-grade, and economical fitting which is weatherproof and practically indestructible, and at the same time gives most efficient reflecting results. They are for use with a single metal filament lamp, and are supplied in two types, giving either concentrating or distributing illumination, that shown in the accompanying illustration being of the distributing type. The various sizes now manufactured allow for the use of lamps from 50 to 1,000 watts.

Benjamin reflector fittings are extensively used for factory, street, railway, and many other kinds of outdoor and indoor lighting, and it has been found necessary, in order to meet the growing requirements of the trade, to develop the line further, as we have mentioned above.

A Remarkable Sign.

The accompanying illustration shows a sign erected recently in the Strand by the **Franco-British Electrical Co., Ltd.** (50, Oxford Street, London, W.). It is noteworthy in that it created such a large crowd when first put into use, that the police authorities requested that it should be temporarily discontinued. It is an ingenious application of the flashing sign principle, arranged so as to give the effect of the throwing of balls between the two clowns represented in the picture. The word "Cinema" thus appears to be gradually built up out of luminous balls.

Mazda House.

Fig. 1.

In our last issue we were only able to make a brief reference to the opening of the new premises of the British Thomson-Houston Co. under the above name, where all business connected with lamps and wiring supplies will in future be carried on.

The illustrations reproduced on this page will serve to give some idea of the size and equipment of these model offices. Fig. 1 is a view of the Sales Counters on the ground floor, where every effort has been made to ensure that purchasers will procure what they desire with a minimum of delay or trouble. Three separate counters are arranged to supply Mazda lamps, Gem and carbon lamps, and wiring supplies respectively. It will be noticed that in this room good use has been made of the "Eye-Rest" system of indirect lighting, which is also employed in many of the private offices on the first floor.

On the fifth floor is the Mazda lamp stock-room, where all types and sizes of Mazda lamps will be stored in sufficient quantities to meet any demand. On this floor also the packing will be done. Fig. 2 shows one of the store-rooms.

Fig. 2.

Mazda House is up to date in all its details. The lighting, heating, and lifts are all worked electrically, and besides a very complete system of intercommunicating telephones, there is an installation of automatic sprinklers.

The Illuminating Engineering Department, a very important feature in the new offices, is situated on the second floor. It may be mentioned here that this department has been specially organized in order to give customers the benefit of expert advice free of charge on all matters connected with illumination.

Catalogues and Lists Received.

From the **British Thomson-Houston Co., Ltd.,** a very comprehensive list of Gem Lamps, which includes, besides all particulars of sizes and prices, some interesting data on the comparative efficiencies of Gem and carbon filament lamps; from the **White Electrical Instrument Co.** (formerly James Pitkin & Co.), of 2 and 4, Gloucester St., Clerkenwell, London, a list of Portable and Switchboard Ammeters and Voltmeters, &c.; from the **Metallic Seamless Tube Co., Ltd.** (Wiggin St., Birmingham), a pamphlet describing "Metallic" Fuseboards, fitted with swing-back frame.

Osram Lamps.

Messrs. The General Electric Co., Ltd. announce the following reduction in the price of Osram lamps :—

20 to 30 volts, 5 to 16 c.-p. (pear shape) 2/1 each.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

ONE of the most interesting recent papers has been that by NICHOLS (*Jour.* Franklin Inst., April) on **Daylight.** The author gives a number of curves showing the effect on the quality of daylight of different climatic conditions, the characteristic spectra derived from various types of clouds, and the peculiar colours at sunset and sunrise. This last effect is also exhibited by a series of curves mapping the variation in each spectrum colour throughout the day.

LUCKIESH (*T.I.E.S.*, April) also deals with the effect of light of different colours, pointing out how the fact of the eye not being achromatic affects acuteness of vision. Owing to this defect of the eye, sharper definition can be obtained with monochromatic light than by white light, and the author finds that the best result is obtained with light in the neighbourhood of $0{\cdot}58\mu$.

The **Formation of Shadows** by Artificial Li_ht has been dealt with by J. G. CLARK (*J.G.L.*, April 30), who explains how the sharpness and tone is affected by the size of the source and type of shade. Numerical data and diagrams substantiating this are presented. In the course of his remarks the speaker also pointed out that indirect lighting is not "shadowless," but merely produces very soft shadows. The architectural appearance of pillars, alcoves, and recesses demands a certain amount of shadow.

Turning next to practical applications of illumination, we may note BERTELMAN's remarks on sign-lighting (*Licht u. Lampe*, May 9), in the course of which he protests against the frequent use of flame arcs at a low level; such lamps, when used for shop-fronts, should, he says, be hung at least 4 metres above the ground. The same journal has an account of an ingenious variety of fixtures made of basket-work.

L. C. PORTER (*T.I.E.S.*, April) discusses **Ship-lighting,** dividing vessels into ferryboats, river steamers, large passenger vessels, battleships, &c. Some figures for the illumination and consumption of electricity are given in the case of various schemes of lighting, and there are also photographs of some typical installations; the use of lamps mounted straight on the ceiling is a very common feature.

ELECTRIC LIGHTING.

Several articles allude to the new **Drawn-wire Tungsten Filaments** (*Licht u. Lampe; E.T.Z.*, May 9). The great advantage of such filaments is their strength, but the process involved certain difficulties in manufacture in other respects which had to be overcome. PIRANI and MAYER (*E.T.Z.*, May 2) present a series of statistical data connecting the specific consumption and estimated temperature of filaments, and it is shown that the results substantially confirm those of earlier investigators. An article in *Licht u. Lampe* compares the efficiency of tungsten and arc lamps. The author shows that the current comparisons are commonly misleading, owing to the fact that the calculations are not based on mean spherical candle-power in both cases. Metal filament lamps do not in general consume less than 1·7 watts per M.S.C.P., while an ordinary modern arc lamp should consume only 0·8 watts per M.S.C.P.

Turning next to arc lamps, we may note the continuation of the series of articles analyzing recent patents on mechanism in the *Zeitschrift für Beleuchtungswesen.* An interesting contribution by G. M. LITTLE (*Elect. Journ.*, Feb.) discusses **The Metallic Arc.** In such arcs the light comes, not from a crater, but from the bridge of vapour; but, in general, the vapour is brightest near the negative electrode. To avoid waste of light through obstruction, it is therefore preferable to make this electrode the upper one. This is not the usual practice, but the author describes how it can be done by employing a special down-draught to promote stability. Under these conditions the tendency of the flame to burn with an outer envelope of soot, and thus lose much of its brilliancy, is avoided. Commenting on the composition of electrodes, the author explains that a small amount of titanium oxide is desirable, and that this material apparently plays a part not unlike that of the cerium oxide in the incandescent mantle. An article in *The Electrical Review* (New York) also deals with metallic arcs, illustrations of various arrangements of globes and electrodes being given; the arcs are commonly operated on the series system.

Licht und Lampe (April 25) contains an interesting account of the use of the **Moore Tube System** in Germany, photographs showing its use in restaurants, photographic works, &c., being presented. Reference is also made to its installation in the Technische Hochschule in Breslau.

J. Pole (*E.T.Z.*, May 9) gives an account of a **New Form of Mercury Vapour Lamp** just brought out by the Cooper Hewitt Co. in New York. It utilizes a tungsten lamp run in series with, and surrounded by, a circular tube containing luminescent mercury. The whole is enclosed inside a hemisphere of diffusing glass so as to blend the colours. The arrangement for starting the tube is also novel. The tube need not be rocked, a development of the static discharge method being employed to set the lamp going. The specific consumption is given as about ¾ watt per mean lower hemispherical c.-p.

GAS, OIL, AND ACETYLENE LIGHTING.

During the past month a lecture was delivered by J. Abady on **Light and Competition** (*G.W.*, May 11; *J.G.L.*, May 14). The author presents figures for the cost of gas and electric lighting, in the course of which the results of some tests on metal filament lamps (giving 1·42–1·81 watts per c.-p.) are given. Discussing the possibilities of future progress, the author suggests that in the case of electricity greater efficiencies will be secured by the use of luminescent vapours, while in the case of gas, although there may be no immediate prospect of any vast improvement in the quality of the gas itself, there are great possibilities in the improvements of burners. More attention should also be given to methods of altering the distribution and colour of the light from gas lamps.

S. B. Chandler, in the course of some "Remarks on Gas Supply," lays stress on the value of co-operation from architects and builders in the fixing of supply pipes while buildings are in course of construction. Reference is also made to the tendency towards concentrating very powerful lights outside shop windows, which should give place to more scientific methods in future.

Among other items, we note a contribution from Prof. Bone on Surface-Combustion, an interesting note on the effect of gas light on plants (*J.G.L.*, May 7), and several general contributions in *The American Gaslight Journal* dealing with high-pressure gas lighting.

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Das Moore Licht (*Licht u. Lampe*, April 25).
The Electric Sign in England (*Elec. Rev.*, N.Y., April 20).
Series Metallic Flame Arcs (*Elec. Rev.*, N.Y., May 11).
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Abady, J. Light and Competition (*Gas World*, May 11 ; *J.G.L.*, May 7).
Bone, W. A. Surface Combustion and its Industrial Applications (*J.G.L.*, May 14).
Chandler, S. B. Some Remarks on Gas Supply (*Gas World*, May 4 ; *J.G.L.*, April 30).
Glover, B. G. High-Pressure Gas Lighting (*Am. Gas Light Jour.*, April 22).
Godinez, F. L. The Significance of Originality in Modern Gas Lighting (*Am. Gas Light Jour.*, April 15).
Luther, C. A. Illumination of People's Gas Building, Chicago (*Am. Gas Light Jour.*, May 1).
Gas Lighting and Plants (*J.G.L.*, May 7).
Some Notes on High-Pressure Gas Lighting (*Am. Gas Light Jour.*, April 29).
Beleuchtung mit flüssigen Leuchtmaterialen (*Z.f.B.*, April 30, May 10, 20).
Acetylene in Mines (*Acetylene*, April).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
G. W.—*Gas World.*
Illum. Eng., N.Y.—*Illuminating Engineer of New York.*
J. f. G.—*Journal für Gasbeleuchtung.*
J. G. L.—*Journal of Gaslighting.*
T. I. E. S.—*Transactions of the American Illuminating Engineering Society.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

Some Publications Received.*

The Art of Illumination. By Dr. Louis Bell.—This is a new edition, entirely rewritten, of what was practically the pioneer book on the subject. It deals with all the important developments which have taken place since the publication of the first edition.

The Development of the Incandescent Electric Lamp. By G. Basil Barham.—A comprehensive review of the manufacture of lamps, especially the modern forms of tungsten lamps.

Practical Exercises in Physiological Optics. By G. J. Burch.—Contains outlines of a large number of experiments for the use of practical classes in optics.

Annuaire International de l'Acétylène for 1912. Published at the Office Central de l'Acétylène, Paris.—This volume is considerably elaborated, and includes some preliminary chapters dealing with illumination in general. A large amount of information is also included on the subject of acetylene and its uses.

Proceedings of the American Gas Institute, 1911.—Contains a detailed record of papers and discussions of the last session, issued in two volumes.

Treatise on Practical Light. By R. S. Clay.—This aims to treat the study of optics in a more practical manner than previous works on the subject, applying its principles to lenses, photometry, and questions of colour.

Institution of Gas Engineers, Transactions for 1911.

Welsbach Illumination Data Book.—Issued by the Welsbach Co. of Gloucester City, N.J., U.S.A., and containing a complete set of up-to-date diagrams, polar curves, and other particulars for the various lamps made by the Company.

The Gas Solicitor's Handbook.—A neat little booklet summarizing rules, suggestions, and information with regard to Welsbach illumination.

Soren Hjorth, Inventor of the Dynamo Electric Principle.—A pamphlet setting forth the claims of Hjorth to this title.

Recent Experiments with Invisible Light.—A reprint of the lecture by Prof. R. W. Wood before the Royal Institution of Great Britain.

On the Ultra-Violet Energy in Artificial Light Sources. By Dr. Louis Bell.—Reprinted from *The Electrical World.*

Dichromatisches Sehen. By Dr. F. W. Edridge-Green.

Reports of the Sub-Committee of the American Illuminating Engineering Society on Nomenclature and Standards.—Reprints of reports presented at the Conventions of 1910 and 1911.

Visual Acuity with Lights of Different Colours and Intensities. By D. E. Rice.—Reprinted from 'Archives of Psychology,' New York.

Lord Kelvin. By Prof. Silvanus P. Thompson.—A short biography, written for the International Electrotechnical Commission and published by them in English and French.

We also have to acknowledge the receipt of the following : *Journal of the Royal Society of Arts, American Chemical Journal, The Physical Review, The American Gas Institute News, Journal of the Franklin Institute.*

*** To many of these we hope to refer in greater detail shortly.**

7

The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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EDITORIAL.

The Congress on the Prevention of Industrial Accidents in Milan.

THIS Congress, which was held in Milan from May 27th to 31st, proved a great success. About 450 delegates and members were present, including many well-known manufacturers, officials of associations for the prevention of accidents and insurance companies, and Government hygienic authorities; altogether the Congress served to show how much good work can be done by informal and amicable discussions.

Readers will find on pp. 335 and 336 a succinct account of the proceedings. Many important matters, including the fencing of belting and moving machinery, the artificial humidification used in cotton-spinning mills, the prevention of inhalation of dust and steam, &c., were discussed, and amongst these, we are glad to say, illumination was assigned an important position. In a paper read by the writer on this occasion the claims of good lighting as a means of avoiding accidents, and with reference to public health, were put forward (see pp. 337-343). The opinion was generally expressed that this subject ought to receive fuller attention in future, and the movements going on simultaneously in all the chief European countries show that this impression is not confined to any one locality. The movement is an International one, and for this reason we strongly advocate the formation in all the important countries of special commitees similar to that already constituted in France and about to be formed in England.

We may perhaps single out two points which received special notice at Milan. In the first place every one was struck by the justice of the idea that *the eye* deserved to be catered for as judiciously

as any other part of the body. We already take measures to prevent the lungs of workers being injured by breathing foul air or small particles of grit, &c., and we are also prepared to make special arrangements to avoid any risk of the system being affected by poisonous materials. Why, therefore, should not reasonable care be demanded in dealing with that most vital organ the eye? The justice of the demand is all the greater because the conditions which are prejudicial to eyesight are also, in the long run, injurious to general health and destructive to efficient labour and good workmanship.

The next point (which came as a revelation to many of those present at the Congress) was the ease with which measurements of illumination can now be made. A deep impression has already been made by the record of work of the Illuminating Engineering Society, and the data regarding the illumination of printing works were spoken of as most valuable for future reference. Such measurements are indispensable as a record of lighting conditions, and will doubtless play an important part in connexion with investigations in factories in the future. As an instance we need only mention the remarkable series of observations taken by Mr. D. R. Wilson, and included in the most recently issued report of H.M. Chief Inspector of Factories in Great Britain, on which we shall have something more to say shortly.

It is, of course, too much to expect that we should be able to state the requirements of each industry at once. At present we can only make a few general recommendations such as will strike employer and employee alike as judicious and reasonable. What we desire is that the various friendly societies, insurance companies, &c., and the factory inspectors of the respective Governments, should now make a practice of measuring illumination and taking note of the lighting conditions which each trade seems to require. In particular, we should like to see a record of the conditions of illumination which prevailed when any accident occurred and investigations set on foot to trace the connexion between poor lighting and defective health or eyesight. It is truly a big task. But it is one that could doubtless be undertaken under the supervision of the national committees we hope to see established.

The Annual Report of H.M. Chief Inspector of Factories.

For several years we have noted with interest the increasing space devoted to illumination in the reports of H.M. Chief Inspector of Factories in this country. We have now before us the newly issued report for the present year, in which Sir Arthur Whitelegge announces the intention of referring the complex question of industrial lighting to a specially constituted committee. Meantime preliminary researches of a most painstaking and comprehensive kind have already been undertaken for the Home Office by Mr. D. R. Wilson, and are embodied in a special report occupying 38 pages. Frequent references to lighting are also made in the sectional reports of the various inspectors, and altogether it may be said that at least 12 per cent of the space in the present report is occupied with this subject.

We must postpone detailed treatment of Mr. Wilson's admirable compilation until our next number. For the present we wish to confine ourselves to giving a sketch of the ground covered and expressing our appreciation of the very thorough manner in which the work has been carried out.

The introductory remarks show that the work of the Illuminating Engineering Society, and the references made in this journal from time to time to the hygienic aspects of lighting, have been closely followed. The results of about 2,500 observations of daylight and artificial illumination in various classes of factories, including weaving sheds, cotton-spinning mills, &c., are assembled

in tabular form, and a series of diagrams are given showing correct and incorrect methods of arranging lights with reference to the work. In conclusion, some general figures for the amount of illumination at present utilised in various departments are given, and it is pointed out that the following conditions should be fulfilled: (1) The illumination must be adequate; (2) "Glare" effects must be absent; and (3) no troublesome shadows must be cast on the work.

No attempt is made to prescribe a minimum illumination, but the publication of this complete series of data should be very serviceable in this respect in the future. We are glad to see that, in addition to the provision of sufficient light, the necessity for adequate shading is insisted upon, and examples are quoted to show the increased illumination and the greater comfort to vision which the use of a proper reflector ensures.

It cannot be doubted that the issue of this report will give a considerable impetus to more scientific illumination. The authoritative recommendation of these simple precautions in lighting, and the demonstation of the ease with which measurements of illumination can be made, will surely influence manufacturers and lead many to take an interest in the subject.

Before quitting this report we should like to note one other announcement, namely, that a site has been secured for a proposed Museum of Safety Appliances in Westminster. Visits have been made to similar institutions in various continental cities, and it is hoped that the Museum will provide an incentive to the study of industrial hygiene and the prevention of accidents.

The Optical Convention.

The Optical Convention which has just terminated in London was notable in several respects, but from our standpoint especially so on account of the prominent place taken by the section devoted to illuminating engineering.

A broad conception of optics should surely include this branch of knowledge. The illuminating engineer must necessarily study the laws of reflection from diffusing and polished surfaces, and the photometric expert meets many problems involved in the design of optical instruments and in physiological optics. The designer of prismatic glassware, it need scarcely be said, must understand all about the laws of reflection and refraction.

There are therefore many points of common interest in scientific optics and illuminating engineering, and it is quite natural that this should be so, seeing that both subjects are based ultimately on the study of *the eye*. The President, Prof. Silvanus Thompson, in his inspiring opening address, pleaded for better educational facilities in optical science. He alluded to the considerable progress made in the subject of illuminating engineering, and showed how the advance in the manufacture of optical apparatus on the Continent was in a great measure due to their superior organization of research and more intimate co-operation between the theorist and the manufacturer. At present no university in this country has yet created a Chair of Optics, but we hope that the day is not far distant when a special department of optics and illuminating engineering will be organized at several of our greatest institutions.

Several of the papers read at the Optical Convention dealt with subjects of interest to the lighting engineer. The exhibition itself was remarkable for the fact of gas and electric lighting exhibits being shown side by side as being of common interest from the standpoint of utilization of light. Not only did these exhibits illustrate the tendency to pay more attention to globes and reflectors with a view to the proper distribution of light, but they also served to show how important is photometry in working out the design of such appliances. A few years ago very few of the manufacturers in this

country would have been willing to prepare polar curves of the light-distribution from their lamps. At this exhibit such curves were displayed side by side with the actual lamps as a matter of course, so that visitors could see at a glance the forms of shades or reflectors employed and their effect on the distribution of light.

It is also noteworthy that quite a number of firms exhibited photometric apparatus for tracing out polar curves, the appliances, in several instances, being publicly shown for the first time.

The Standard Specification for Street Lighting.

The matter of the Standard Street Lighting Specification which is being drawn up by the Joint Committee of the Institutions of Gas and Electrical Engineers, the Illuminating Engineering Society, and the Association of Municipal and County Engineers, is still *sub judice,* and it would therefore be premature to enter into any discussion of the subject. Whatever the final conclusions may be, we feel sure that any impartial man who takes a broad view of the lighting industry must welcome this attempt to sink personal differences and come to an acceptable compromise on this subject.

We observe that in the Annual Report of the Institution of Gas Engineers a short reference is made to the general lines on which the discussion has proceeded, but it was explained that the final draft report was still in course of preparation, and to be considered by the Council of the Institution. In the circumstances we think it would have been preferable not to have courted discussion by outsiders. The Council of the Institution, however, apparently thought otherwise, and Mr. J. Abady (who is not a member of the Institution of Gas Engineers or the Joint Committee) was allowed an opportunity of speaking on the subject.

Mr. Abady's extreme views on these matters are, of course, familiar to us. Seeing that the specification is not yet ripe for public discussion, we see no object in considering them in detail, except to say that his objection to measuring horizontal minimum illumination, besides being apparently opposed to the views of the Joint Committee in this country, finds little support from Continental experts (including Dr. Bloch, Prof. Drehschmidt, and Dr. Bunte).*

Mr. Abady states that he is uncertain as to who is responsible for the initiative in forming this Committee. We presume that he is also ignorant as to its constitution, and knows nothing of its work beyond what has been made public in the Annual Report of the Institution of Gas Engineers (seeing that the proceedings of the Committee are at present treated as confidential). Unless he has been misreported, some of his remarks were most discourteous. We happen to be informed as to the membership of the Committee, and can imagine few things more ludicrous than Mr. Abady's assumption that they know nothing of the subject, and that their combined knowledge is entirely inferior to his own.

We ourselves are strongly in favour of a judicious form of specification which takes into account the views of all those interested in its subsequent working, and, if possible, one which might eventually be made the subject of international agreement. One thing is quite certain. In order to be acceptable such a specification must be the combined work of a responsible committee of experts. The day is past when the views of an individual, however gifted, can be imposed on the lighting industry as a whole. We hope, therefore, that the Council of the Institution of Gas Engineers will not allow Mr. Abady's views to deter them from carrying through the good work on which they are engaged.

LEON GASTER.

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* *Illum. Eng*, Lond., Vol. IV., 1911, pp. 418, 419.

Review of Contents of this Issue.

At the beginning of the Technical Section (p. 335) will be found a brief account of the **First International Congress for the Prevention of Industrial Accidents,** recently held in Milan. It will be noticed that special attention was given at this Congress to the question of good illumination as a means of avoiding accidents, a paper on this subject being read by Mr. L. Gaster, delegate of the Illuminating Engineering Society in this country. A large range of subjects was covered in the papers, including the question of moving machinery, belting, pulleys, &c., the removal of injurious dust in various grinding processes, and the presence of steam- and water-vapour in workrooms.

Following this, on p. 337, is an abstract of the paper (referred to above) by Mr. L. Gaster on 'The Value of Good Illumination as regards Health and as a Means of preventing Accidents.' The author refers to the growing recognition of the need for adequate illumination, as shown by a review of the references to lighting in the official reports of the Chief Inspector of Factories in this country and the views held by authorities on the Continent. The correct position of lamps and avoidance of glare are also mentioned as points of considerable importance in their effect on the efficiency of the worker. The author also quotes from the reports of factory inspectors, mentioning incidents to show how accidents are directly attributable to bad lighting. In conclusion, reference is made to several important steps that have been taken, both in England, the United States, and on the Continent, towards improving the existing conditions by the agency of existing societies and the formation of Committees, with a view to collecting information on the subject. The hope is expressed that the example of the French Government, in appointing a committee on the Hygienic Aspects of Lighting will be followed in other countries.

Following this is a fully illustrated article by An Engineering Correspondent on **Some Interesting Church-Lighting Installations,** in which are described some good examples of the application of illuminating engineering principles to the special problem of church-lighting. Special reference is made to the value of concealed lamps. Batten lighting has been employed with good effect in the lighting of chancels, and cases are cited in which old oil-lamp pendants have been converted to electric fittings with very satisfactory results.

On p. 351 will be found some account of the papers presented at the recent **Optical Convention.** Special reference is made to the opening address of the President, Prof. Silvanus Thompson, in which he emphasizes the need for better educational facilities in the optical industry. He also alludes to the great progress in illuminating engineering. A feature of the Exhibition was the special section devoted to illumination, in which a large number of firms dealing with gas and electric lighting exhibited various forms of globes, shades, and reflectors, and photometrical apparatus. It is worthy of note that full information was given with regard to many of the illuminants exhibited, polar curves of light-distribution from each illuminant being exhibited side by side with the acutal lamp. Some new forms of photometric apparatus were also shown for the first time.

Among other items in this number may be mentioned the report of Mr. Treacher Collins on the **Lighting of the House of Commons,** in which incandescent electric lamps and Holophane reflectors are proposed to be used (p. 334). There is also an account of the **Ideal Home Exhibition,** written from the illuminating engineering standpoint (p. 359), and at the end of the issue will be found the usual **Trade Notes** and the **Review of the Technical Press.**

The Lighting of the House of Commons.

(Report to the First Commissioner of Works regarding a Proposal to Substitute Electric Light for Gas in the Debating Chamber of the House of Commons.)

It will be recalled that in our issue for June we referred to some questions which were asked recently in the House of Commons on the subject of illumination and the lighting of the House. The subject has been under the consideration of the First Commissioner of Works, and we print below a Report recently presented to him by Dr. E. Treacher Collins :—

On April 26th, 1912, I, together with Dr. Parkes, visited the Debating Chamber at the House of Commons, and inspected the present arrangements for lighting it with gas, and the proposed new arrangements for electric lighting, in order to see if the latter were in any way likely to be injurious to the eyesight of Members of Parliament.

I found that the proposed electric lighting is to be effected by groups of three metal filament incandescent lamps enclosed in a Holophane globe, which is placed over a square pane of ground glass having an amber tint, and an ornamental pattern on it.

(*a*) Ultra-violet rays may produce irritation of the eyes ; they are to a great extent cut off by the passage of light through glass, and are completely cut off by glass of an amber tint.

The rays from the electric lamps at the House of Commons will be filtered by passage through three layers of glass : (i.) that covering the lamp itself, (ii.) the Holophane globe, (iii.) the ornamental pane of glass. The ultra-violet rays will be cut off by the amber colour of the latter. There is, therefore, no fear that the eyesight of Members of Parliament will be affected by ultra-violet rays.

(*b*) An amount of illumination equal to one candle-foot is the minimum amount usually considered requisite for reading purposes. I was informed that the amount of illumination on the benches with the present gas lighting is four-fifths of a candle-foot, and that the same amount or more, as I should think desirable, can be obtained with the electric lighting.

The amount of illumination in all parts of the Debating Chamber is not the same. The illumination from the roof is supplemented on the back benches by lamps fixed to the pillars in front of them. These do what I was told was required of them, *i.e.*, light up the faces of Members so that they can be seen by the Speaker. They are not, however, situated in the best position to enable Members on the back benches to read. For this purpose it would be desirable that the light should come from behind them.

(*c*) Uniformity of illumination. Variations in the intensity of illumination at its source, so that there are glittering or glaring points, is often found to be a source of discomfort to the eyes. In the squares in the roof of the Debating Chamber I found the illumination to be more uniformly diffused and freer from points of a glittering character when they were lit by electric light than when they were lit by gas. This is accounted for by the dispersion of light which is produced by the Holophane globes around the electric lamps.

(Signed) E. Treacher Collins,

F.R.C.S., L.R.C.P.

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

The First International Congress for the Prevention of Industrial Accidents.

(Held in Milan, May 27–31.)

THE International Congress for the Prevention of Industrial Accidents, which has just taken place in Milan, made an interesting supplement to the work of the Congress on Industrial Hygiene, held in Brussels in 1910. It was also most fitting that this Congress should take place in Milan, where the first institute to deal exclusively with this subject has been established under the supervision of Dr. I. Devoto.

The Congress took place under Royal patronage. Prof. L. S. E. Luzzatti, late Prime Minister and Hon. President, opened the proceedings in the Castella Sforzesco with a most interesting speech, and Sig. L. Pontiggia, the acting President, gave an account of the objects of the Congress, which was designed to bring together the manufacturer, the insurance expert, and the hygienic authorities to talk over matters of common interest in a friendly way. By this means the ground would be prepared for agreement on reforms beneficial alike to employer and employee. Nothing could have been more striking than the spirit of co-operation shown at this Congress, and it will doubtless pave the way for valuable international action in the future. During May 27th Sig. Battaglieri, Under-Secretary of Posts and Telegraphs, declared the Congress open in the name of the King and the Government, and the subsequent meetings took place in the Royal Palaces.

It will be seen that the subject of chief interest to us—the value of good illumination as a means of avoiding accidents—received special attention. Papers were presented on this point by Mr. V. R. Lansingh (President of the American Illuminating Engineering Society) and Mr. L. Gaster, the latter being present as a delegate of the Illuminating Engineering Society in this country. The general range of the other subjects covered in the papers was also most interesting. Nearly 500 delegates and members were present, other representatives from Great Britain being Mr. C. W. Bowerman, M.P., and Mr. S. Smith (representing the Home Office). Among others who took part may be mentioned: Dr. W. Tolman (representing the United States Navy and Director of the Museum of Public Safety, New York), Sig. F. Massarelli (General Secretary of the Congress, Italy), M. Bocquet (representing the Association Normande pour prévenir les Accidents du Travail, France), M. Boulisset (Inspecteur divisionnaire du Travail, Paris), Comm. H. Breiter (German Consul in Milan), M. Deladrière (Belgium), &c.

The first subject considered was the care and installation of moving machinery, belting, pulleys, &c. Many ingenious devices for fencing and for enabling the belt to be shifted with safety while the machinery is in motion were suggested. Proper fencing for rolling machinery, such as is used in iron and rubber works, laundries,

bakeries, &c., was also insisted upon, a very useful contribution on this subject being presented by Sig. F. Massarelli.

There was also a variety of papers dealing with the removal of fine dust and grit, such as is produced in grinding processes, in stripping and carding machines in the cotton industry, &c. In the cotton industry the breathing of fine dust and fluff is apt to be prejudicial to the health of workers, and should be prevented. Papers were read on the artificial humidification of cotton and the importance of pure, water was emphasized. Infectious diseases have not infrequently been propagated by contaminated water, and the general opinion was expressed that a standard of purity would be very beneficial. (As an instance of up-to-date action in England, it may be mentioned that the most recent regulations issued by the authorities already prescribe such a standard.)

The presence of much steam and water-vapour in the atmosphere of workrooms (such as is apt to be found in the hat and cap trades, in silk mills, &c.) was also recognized to be unhealthy, leading to general weakening of the body and interfering with the digestive organs. The manipulation and design of rotating drying machinery (hydro-extractors) was also discussed. Owing to the high speed of revolution, weakness in the design or unequal distribution of the charge might have serious results. Sig. Massarelli presented a paper dealing very fully with centrifugal apparatus for sugar refineries. Discussion also took place on methods of "earthing" electrical circuits, and the regulations in this country on the subject were mentioned as being most up to date.

Among the miscellaneous papers presented, chief interest attaches to those dealing with illumination. It was most gratifying to see how readily members concurred in the view that good illumination was quite as important as proper ventilation, fencing dangerous machinery, &c., and other subjects that they had just been discussing. One point that received full recognition was the need for measuring illumination, and it was shown that considerable progress in this direction had now been made. The paper by Mr. Leon Gaster is reproduced in abstract, and commences on the next page. The communication by Mr. Lansingh was formally presented in the absence of the author, and reference was made to the work accomplished in the United States by the American Illuminating Engineering Society and the National Association for the Conservation of Vision. Allusion was also made to several manufacturing associations in that country which had taken a keen interest in the subject of illumination. In conclusion, a series of illustrations were presented, chiefly showing the use of reflectors to distribute the illumination and at the same time protect the eyes of workers from glare.

A most striking suggestion was made by Dr. W. Tolman. He pointed out that it would often be to the interest of a large firm to have on the staff a permanent "safety engineer," whose duty it would be to keep abreast of all new methods of protecting machinery and caring for the health of employees. Such an expert would act as a link between the employer and the hygienic authorities, and, being on the spot, would be in a position to see that the improvements agreed upon were actually carried out. Another interesting suggestion was that there should be some form of international "danger signal," which should be the same all over the world, and would always be placed in a prominent position near dangerous machinery.

The initiation of this Congress in Italy, where so much good work on industrial hygiene has already been done, is largely due to the efforts of the acting President of the Congress, Sig. L. Pontiggia. Acknowledgment should also be made of the services of the capable Secretary, Sig. F. Massarelli. The next Congress is to take place in 1915. We hope that by then industrial hygiene and illuminating engineering will both have made considerable strides forward, and that their connexion will be still more firmly established.

The Value of Good Illumination as regards Health and as a Means of Preventing Accidents.

By Leon Gaster.

(Abstract of paper read at the Congrès Technique International de Prévention des Accidents du Travail et d'Hygiène Industrielle, Milan, May 27th—31st, 1912.)

The subject of the applications of light in industry is an exceedingly important one at the present moment, and it was with great gratification that I accepted the kind invitation conveyed through your distinguished Secretary, Sig. F. Massarelli, to read the present paper. There are few subjects, I suppose, which have made more rapid strides than industrial hygiene during the last few years. The Second Congrès International des Maladies Professionnelles, held in Brussels in 1910, drew public attention to the excellent work that is now being done all over the world to make labour and industry safer and more congenial to the worker, and I venture to think that the present Congress will, in future years, be looked back upon as marking another great step forward.

The opportunity of bringing forward the claims of good illumination on this important occasion is, therefore, very welcome. The technical side of lighting already forms a vast subject. I may remind you that Sig. Massarelli has already reviewed the progress of illuminants in his admirable recent paper at the Congrès at Brussels. It is my intention to deal with their applications from the standpoint of those responsible for the health and safety of workers—the manufacturers, the sanitary and hygienic experts, the inspectors, &c. Many matters in connexion with industrial hygiene, such as ventilation, good water supply, &c., now receive close attention, and I venture to believe that good illumination will soon be regarded as demanding equally careful supervision.

To the hygienist and sanitary expert the value of light is conceded for two main reasons: (1) its direct influence on the health of workers, and (2) its importance as a means of reducing the number of industrial accidents. It is my intention to deal with these two points in order, laying special stress on the influence of conditions of illumination on the frequency of accidents, a subject of the greatest interest to a Congress of this kind.

In referring to the effect of illumination on health, a distinction must be drawn between daylight and artificial light. The importance of securing adequate admission of daylight to workrooms was recognized by authorities even before they had begun to consider artificial light. For example, the Building Acts in Great Britain and the recommendations of the London County Council on school-lighting included clauses specifying the desirable area of the windows for a given floor-space, &c. Special emphasis has also been placed on the value of abundant daylight in the legislation affecting such trades as enamelling, glasswork, &c., where there is a possibility of lead-poisoning, and in connexion with industries in which special precautions are desirable to avoid a tendency to tuberculosis.[1]

It need hardly be said that habitual insufficiency in daylight illumination imposes a strain on the eyes of workers engaged in such work as printing, knitting, sewing, &c., but this is only one among many of the evils induced by want of light.

As an illustration of the growing recognition of the need for adequate daylight illumination, I cannot do

[1] *Illum. Eng.*, Lond., vol. ii., 1909, p. 373.

better than quote the conclusions embodied in the report of H.M. Chief Inspector of Factories in Great Britain for 1909 :—

"The importance of adequate lighting in industrial employments is obvious as a matter of safety, especially where dangerous processes are carried on ; as bearing upon health in many ways, directly and indirectly. and as a condition of efficient work. On the health side it is hardly necessary to point out that inefficient illumination entails risk, strain, and ultimate damage to the sight, even apart from interference with work, or that it tends to neglect of cleanliness and adds to the risk of working in poisonous materials, or that it increases the need for artificial light, which can seldom be as satisfactory as daylight."

Turning next to artificial lighting, it may be pointed out that we have not only to deal with the unsatisfactory conditions that arise in factories through insufficiency of light. There is room for a vast amount of educational work in teaching managers of factories to utilize their lights to the best advantage. I may mention that in the legislation of Holland on this point, as summarized in the valuable report of the Conseil d'Hygiène de la Seine in 1907, it is recommended that women and young persons should not be engaged in any occupation liable to be unhealthy or dangerous in premises which require artificial light between 9 A.M. and 3 P.M.[1]

The first necessity in lighting, whether natural or artificial, is that there should be sufficient light for the work. In the regulations in Holland a minimum illumination on the work of 10 lux (approx. 1 foot-candle) was prescribed for general work, and in certain trades recognized to be specially trying to the eyes, such as jewellery, sewing and knitting, embroidery, engraving, &c., a minimum of 15 lux (1·5 foot-candles) was specified. In Great Britain the authorities have been strongly impressed by the necessity for attempting to frame more definite rules specifying the amount of light required for various purposes, and the recent Departmental Report on Accidents in Factories and Workshops[2] made special reference to this matter. Researches are still being carried out on this subject, but, meantime, the Report contained the important recommendation that "even before such a standard can be arrived at, it is recommended that the inspectors should be given general statutory powers to require adequate lighting in all places which are a source of danger by reason of insufficient lighting."

Again, in the report of H.M. Chief Inspector of Factories in Great Britain for 1908, various examples of the results of working by insufficient light were mentioned, notably that of girls with weak sight engaged in certain textile mills. In commenting on these conditions, it is remarked: "Sometimes, however, we are met with indifference or reluctance to spend money on this condition for healthy working (*i.e.*, sufficient illumination), *and we have no statutory provision to rely upon.*"

It is evident, therefore, that even in this year the need for some precise standard of illumination was making itself felt. It would appear that it is necessary to move with care in this matter and to collect full information regarding the amount of illumination necessary and feasible for different classes of work, and as to the best means of measurement. Any definite specification of a certain amount of illumination naturally implies that sufficiently trustworthy and convenient instruments for measurement should be available. Fortunately, considerable progress has been made during the last few years towards rendering such measurements more simple and accurate. A considerable amount of work in this direction has been done by the Illuminating Engineering Society in London in obtaining data regarding the illumination in schools, libraries, factories, &c., and the measurement of illumination is coming to be looked upon as quite a convenient and reliable process. Naturally, we may hope for still further progress to be made in the course of the next few years.

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[1] *Illum. Eng.*, Lond., vol. ii., 1909, p. 319.

[2] Blue Book, 1911, obtainable from Wyman & Sons, London.

In the absence of complete information, it may be necessary in many cases to be satisfied with wide and general recommendations on illumination for the moment. But I would urge on this Congress the importance of at once making preparations for the desired data to be collected in future.

It must not be assumed that the provision of sufficient light is all that is needed. It is equally essential that the light should be wisely used. One of the greatest defects to be met with in much of the factory-lighting of to-day is that the lamps are not sufficiently shaded and are too frequently placed in positions in which they dazzle the eyes and impose a distinct strain on vision. Very few of the modern illuminants are sufficiently mild in intensity to be used at close range in this way.

Another point that requires attention is that the lamps should be placed in the right position. In writing, for example, it is a continual source of inconvenience if the lamps are situated on the right hand, so that a shadow of the hand is cast just where one wishes to see the page. The light in such cases should preferably come from over the left shoulder. This defect is not an uncommon one in banks and offices. It need hardly be added that in all mechanical operations (cutting, drilling, &c.) the direction from which the light comes is very important. Also that positions of lights which result in a shadow of the head or body of the operator being cast on his work should be avoided. Yet another defect in lighting to be guarded against is the use of unsteady and flickering sources of light, which are notoriously trying to the eyes.

All these defects must tend to increase the strain of employment and be prejudicial to the general health. In addition to this, there are certain occupations which are specially trying to the eyes, such as textile work, sewing, lace-making, engraving, watch-making, printing, &c., where good illumination is particularly essential. Dr. Gallenga, in a communication to the second Congrès International des Maladies Professionnelles in Brussels in 1910, gave his experiences regarding the tendency to deterioration in eyesight of apprentices in printing works, and I understand that valuable work on this subject is now being done by Dr. L. Carozzi.

So far I have spoken mainly on the value of good illumination in assisting an operator in his daily work and diminishing the number of absentees through ill-health. This is naturally a matter of considerable consequence to manufacturing concerns (the more so in Great Britain on account of the recent Workmen's Compensation Act), and likewise to insurance companies, which have to meet claims for compensation arising through ill-health traceable to bad lighting.

But there is another point that is, perhaps, equally important, namely, the value of good illumination from the point of view of safety. Those who have studied this subject are well aware of the considerable number of mishaps that arise through defective lighting. The Fidelity and Casualty Co. of New York, in a recent report, placed bad lighting *first* in a list of causes leading to accidents. Additional evidence is provided by a curve, which was originally published in *The Journal of Industrial Hygiene*, showing the percentage of accidents that occurred at various times in the year.[1] Experience shows that it is in the dark winter months, when artificial light has to be largely relied upon, that mishaps mainly occur. It has also been stated that a relatively large number of accidents occur after 4 P.M., this being the time at which artificial light becomes necessary in the winter time, and that the amount of "spoiled work" during this period is exceptionally great.

Among other obvious necessities may be mentioned the illumination of dangerous machinery. It is not of much value to place a guard round a dangerous machine if the light is so poor that its outlines cannot be clearly distinguished, and many a machine that would be considered safe in a well-lighted room becomes dangerous to life and limb if allowed to run in semi-darkness.

[1] *Illum. Eng.*, Lond., vol. iv. 1911, p. 578.

At the important Congrès International des Maladies Professionnelles, held in Brussels in 1910, a special recommendation was inserted regarding the adequate lighting of dangerous machinery. And the Departmental Committee on Accidents in Factories in Great Britain stated that inadequate lighting is a "very frequent cause of accident and of grave danger, especially in the smaller printing works and in the Midlands."[1]

It may be pointed out that a bright light placed in the full range of view at the top of a flight of stairs, or in front of some obstacle, may actually be the cause of a man stumbling, owing to his eyes being dazzled. A case is mentioned of a man who walked off a platform and was killed—on some scaffolding—owing to this very cause; even those around him did not realize that he had not solid footing until he actually fell.

Many other instances of the way in which imperfect lighting leads to accidents might be mentioned. Besides the avoidance of dazzling lights, the direction from which the light comes is often important. For example, in certain tailoring works, in which the hand is held quite close to the sharp, cutting edge of the tool, a bad shadow momentarily obscuring the tool may not only lead to spoiled work, but also to mutilation of the hand of the worker. Again, quite apart from actual personal mishaps of this kind, it is well known that badly lighted plant is apt to be neglected and allowed to become dirty, thus paving the way for an ultimate breakdown.

A special case might, no doubt, be made out for the need for good illumination in mines. It is difficult in such dark surroundings to bring up the illumination to the same order as that above ground, but the supreme importance of the matter can scarcely be doubted. Here, as elsewhere, good illumination is one of the most effective safeguards against accidents. Concern has recently been caused by the spread of a nervous affection of the eyes known as "nystagmus," on which several papers were presented at the Congrès in Brussels in 1910. According to the views of Dr. J. Court of Staveley and of the late Dr. Thompson of Cardiff, it is due largely to the defective illumination produced by miners' lamps, so that better methods of lighting may be found to prove the desired remedy. This view has been taken by Dr. Llewellyn in a recent paper presented to the Royal Society. During the last year no fewer than 1,618 men received compensation owing to their being afflicted with this malady, which is now coming to be regarded as an "industrial disease." Among the causes of the affection he places defective illumination first.

Having thus briefly surveyed the question of the value of good lighting in factories, especially as a safeguard against accidents, I should like to conclude by a brief review of the recent important steps that have been taken to improve matters in this respect and to gain fuller information. During the last few years there have been quite a number of valuable conferences on the subject. I have already alluded to the interest taken in illumination by the Home Office in Great Britain, as exemplified in the recent reports of H.M. Chief Inspector of Factories, and the emphasis laid on good lighting by the recent Departmental Committee on Accidents.

Meantime other countries have also been active. I need not remind you of the existence in Milan of the first Institute devoted to Industrial Hygiene, under the supervision of Dr. L. Devoto, the work of which is already widely appreciated, and is destined to receive even fuller recognition in the future. I trust that Italy, which has taken this great step, will continue to be in the front in studying the industrial importance of good illumination.

Next, I should like to recall the interesting and unique Congress on Industrial Hygiene which took place in Brussels in 1910, and to which I have several times had occasion to refer in this paper. On that occasion important papers on lighting matters were read by your distinguished Secretary, Sig. F. Massarelli, Dr. F. Terrien, Dr. A. Broca, and others, and I myself

[1] *Illum. Eng.*, Lond., vol. iv, 1911, p. 193.

had the privilege of reading a paper on 'The Hygienic Aspects of Illumination.' Since the date of the Congrès its distinguished President, Dr. A. Moeller, has published an article on the same subject, in which great stress is laid on the need for international co-operation in this matter.[1]

A great step has also been taken in the appointment, by the French Government, of a Committee on the Hygienic Aspects of Illumination, on which prominent physiologists and oculists, engineers and physicists, and inspectors of factories are represented.[2]

It appears to me to be extremely desirable that this enterprising step on the part of the French Government should be followed in other countries. I have already made representation to this effect, and I trust that the time is not far distant when similar committees will be instituted elsewhere. In such a matter as this, international co-operation would be of immense assistance.

I must also not forget to acknowledge the valuable pioneering work in stimulating public interest in illumination which has been carried out by the Illuminating Engineering Society in the United States during the past few years. A new body, the National Association for the Conservation of Vision, has also now come into existence in that country, and will doubtless supplement the work of the Illuminating Engineering Society in an effectual manner.

In England there are several societies which have devoted much attention to industrial hygiene, but I would like to single out for special mention the Royal Society of Arts, which, for more than 150 years, has made a constant practice of encouraging investigation on problems of the day.

The Illuminating Engineering Society in London, although only formed in 1909, has already been signally successful in this direction, and I am glad to say that it includes among its members many of the greatest Continental authorities on various aspects of illumination, and is, therefore, in an exceptional position to promote international cooperation in these matters.

This leads me to mention one concluding step which should prove of the very greatest importance in raising the status of illumination in the future, namely, the resolution passed at the International Electrical Congress at Turin last year, sanctioning the formation, by the Illuminating Engineering Society of London, of an International Commission on Illumination. This Commission, it should be explained, is to be competent to cover the whole field of illumination. It will deal with such questions as photometry, nomenclature, symbols, the rating of illuminants, &c., but it will also have power to study more practical questions, such as the amount of illumination required in various industrial employments, the hygienic effects of the various illuminants, and in dealing with such it will naturally avail itself of the conclusions reached by the expert committees on the hygienic aspects of lighting suggested above, and should have great weight in ensuring their being carried into effect in practice.

This International Commission on Illumination will also be recruited from local committees in each country, many of the members of which might naturally also be members of the national committees on the hygienic aspects of lighting. In this way all these various agencies could work hand in hand for the improvement of illumination, and assist each other. It might also be suggested that in allotting the work each country might be charged with a certain section in which it was specially interested and particularly fitted to perform. That the results collected should be sent periodically to the various committees and discussed at international conferences.

What, therefore, are the steps which may be suggested as a means of improving industrial lighting, and what parties are likely to benefit by them?

One step I have already indicated, namely, the formation of Governmental Committees on the Hygienic Aspects of Lighting in the chief countries of the world and their co-operation with a

[1] XXme Siècle Jan. 6th, 1912; *Illum. Eng.*, Lond., Feb., 1912.

[2] *Illum. Eng.*, Lond., Aug., 1911, p. 455.

view to securing corroborative evidence where necessary, but avoiding unnecessary duplication of work.

There are several channels through which much valuable information could readily be obtained. For example, factory inspectors, as a preliminary to agreement on definite rules, might be instructed by the Governments in their respective countries to take particulars of the lighting conditions in the factories visited, as well as the condition of health of the workers, in order that we may be able to trace what connexion exists between these two elements. For example, in the case of trades known to be trying to the eyes, particulars of the illumination and also of the eyesight of operators might be noted. It is possible that occasionally the testing of the eyesight of workers might present some difficulties in view of the fact that it is not at present prescribed by law, or that employees are reluctant to submit to test, fearing dismissal if their defects of vision become known. In such cases I venture to suggest that the inspector should be provided with a letter from the Government authorizing him to make such investigations, and explaining that they are carried out for statistical purposes, and that the results will not be used to the detriment of employer or employee.

In reporting on the illumination, inspectors should take note of obvious defects, such as the misplacing of lamps, the use of imperfectly shaded illuminants liable to be prejudicial to vision, and the neglect of adequate lighting for dangerous machinery, &c. But, in addition, I strongly recommend that actual measurements of illumination should be made, as precise data of this kind form a most valuable supplement to personal impressions for future reference. Although not yet perfect, instruments for the measurement of illumination have been very much improved, and the Home Office in Great Britain, I am pleased to say, have already accumulated a considerable amount of data of this description in various factories.

It may also be suggested that a similar record should be kept as regards accidents. This matter is of considerable importance to insurance companies, friendly societies, and labour associations, which are concerned with compensation cases. It may be suggested, therefore, that, when an inquiry is made into the circumstance in which an accident occurred, particulars should be taken of the general lighting conditions at the time, and, if possible, also actual measurements of the illumination made.

It will be seen that in attacking this problem co-operation is most essential. It would, for example, be to the benefit of many companies to arrange for the services of an expert in measuring illumination as well as a physiologist, to work together in tests of this kind, and the committees appointed to investigate the matter would require to be fully representative in character. It would naturally be the function of the committee in each country to make use of all the existing channels of information, and to collect the results together, as well as organizing special researches.

In conclusion, it may be pointed out that an improvement in the conditions of lighting in factories would be an all-round benefit. To insurance companies it would be advantageous, because it would diminish the risk of accidents, both personal and through fire, and mishaps to machinery. I venture to suggest that it would pay such companies to allow specially favourable rates to businesses in cases in which the illumination was up to a prescribed standard (just as is already done when the precautions against fire are exceptionally complete). The employees would indisputably benefit, seeing that they would work under pleasanter conditions and with less risk. And the employer would benefit in several ways. The cost of improving the lighting would certainly not be grudged if once it were shown beyond doubt that improved illumination led to fewer accidents.

The enlightened employer also recognizes that it is to his interest commercially to secure adequate illumination because of the improved output and quality of work. Mr. Roscoe Scott[1] has recently pointed out that in very

[1] *Electrical World*, Feb. 10th, 1912.

few businesses does the cost of lighting amount to more than 5 per cent of the wages bill (in the case of an incandescent lamp factory it was less than 1 per cent), so that any small expense involved in putting the lighting on a proper basis would be very readily repaid by the improved work and freedom from accidents and mishaps secured as a result. An interesting illustration of this fact is afforded by the cotton industry. It appears that "summer-made" goods, in certain classes, are invariably listed at a higher price than those made during the winter, the explanation offered being that, owing to the inferior artificial light in winter, the quality of workmanship is not so good.

In concluding this paper, I feel that a special expression of thanks is due to your distinguished President of the Comité d'Organization, Sig. L. Pontiggia. I venture to hope that, as Direttore della Associazione degli Industriali d'Italia per prevenire gli infortuni del lavoro he will find in this paper some suggestions of interest; and it was largely the kind encouragement and support which I received when I ventured to approach him on the subject of the work of the Illuminating Engineering Society last year, that induced me to think that a paper on the value of illumination as a means of preventing industrial accidents would be of service to this Congress.

It is most fitting that Milan, in which the first institution devoted solely to industrial hygiene was established, should see the first International Congress on the Prevention of Accidents, and I feel confident that this great step forward will lead to most beneficial and important developments in the future.

[Since this paper was written the Home Secretary, in reply to a question in the House of Commons by Dr. A. Lynch, has intimated the intention of the British Government to appoint a Departmental Committee on the Hygienic Aspects of Illumination (see *Illum. Eng.*, June, 1912, p. 284). We have also just received the Annual Report of H.M. Inspector of Factories in which detailed reference to lighting is made, and propose to deal with this more fully in our next number.—Ed.]

The Annual Meeting of the Institution of Gas Engineers.

A great event of the past month for the gas industry was the annual meeting of the Institution of Gas Engineers.

The address of the President (Mr. R. G. Shadbolt) summarized the progress of an eventful year, the industrial outlook naturally receiving special attention. The President for the session 1912–3 is Mr. Woodall. We note that this is the Jubilee year of the Institution, and calls for special celebration.

The papers did not include any detailed reference to lighting matters. Mr. H. Townsend discussed 'The Incidence of the Day-Load,' Mr. A. W. Onslow 'High-pressure Gas for Manufacturing Purposes,' and Dr. R. Lessing 'A Laboratory Method for comparing the Coking Properties of Coal.' Several papers dealt with the education of gas fitters, which was also the subject of a special report.

The Annual Meeting of the Verband Deutscher Elektrotechniker.

The annual meeting of the Verband Deutscher Elektrotechniker took place in Leipsic from June 4th to 8th. The arrangements for the meeting were, as usual, extremely well organized, and the attendance exceeded 900. Reports of Committees on various electrical standard recommendations were presented, and there were also several papers dealing partly with lighting matters. To some of these we hope to refer shortly. A complete account of the annual meeting will be published shortly, and can be obtained by members at a cost of 2mk. 50.

An interesting event was the nomination of Prof. Dr. Budde, the President of the International Electrotechnical Commission, as an honorary member of the Verband.

The next annual meeting is to take place in Breslau.

Some Interesting Church Lighting Installations.

By an Engineering Correspondent.

It is encouraging to observe that the general public are beginning to recognize that there is something more in illuminating engineering than merely making economies in the lighting bill. People are becoming aware that successful illumination is an art, and that it is often of much greater consequence to get the conditions of illumination really satisfactory for the purpose in view than to save a certain sum of money in so doing.

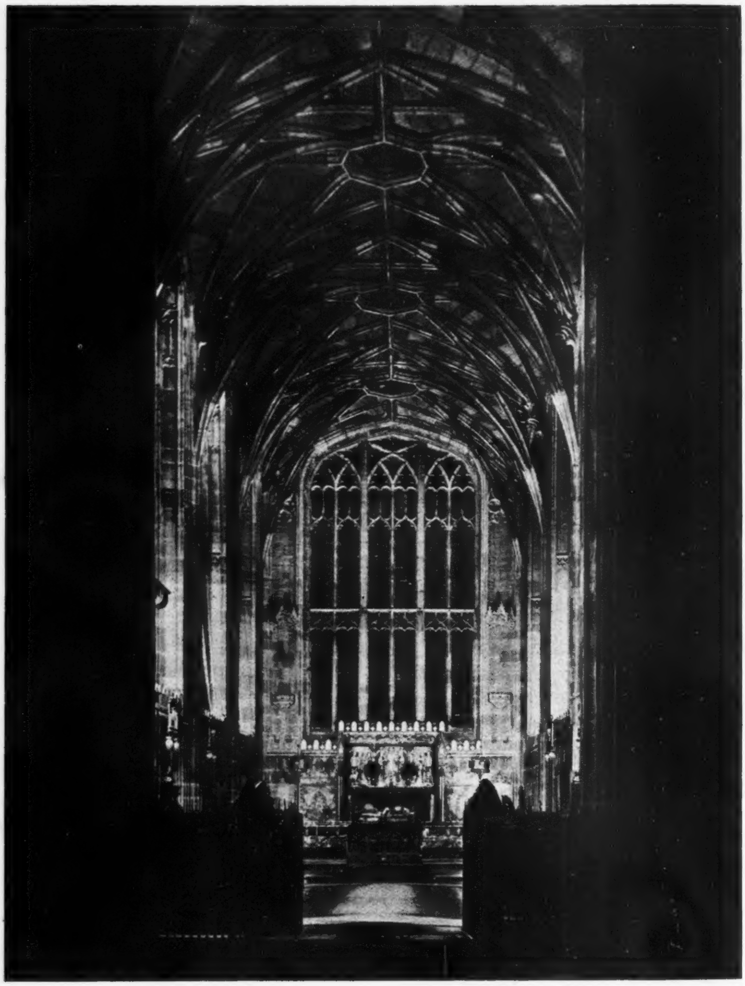

Fig 1.—Chancel of St. Mary's Church, Warwick. Untouched photograph taken by artificial light The lighting is carried out by concealed batteries of reflectors containing Mazda Lamps.

An interesting illustration of this keener perception of the possibilities

of illumination is furnished by church-lighting. Some years ago a special series of articles on this subject appeared in *The Illuminating Engineer.** It was pointed out then that there are many factors to be considered besides expense, and that there is a great opportunity for the lighting engineer's skill in providing conditions of illumination which are acceptable to the worshippers and in harmony with the architectural features of the building. The question must arise how far it is desirable to introduce new illuminants in old surroundings. But in most cases, when objection has been taken, it has been because the lighting was not scientifically arranged. Unshaded lamps hung in the direct range of sight of the congregation inevitably lead to discomfort. Moreover, when the illumination is obtained from lamps at a low level, either unshaded or equipped with unsatisfactory forms of clear glass shades, the whole of the interior decorative effect may be spoiled. The roof of the church will probably be left entirely dark, and consequently invisible, and the walls and pillars may be "patchily" lighted in such a way as to destroy utterly any beauty of form or pattern which the architect may have given to them.

In what follows the author proposes to describe several installations in which very successful methods of illumination appear to have been adopted. The first of these is St. Mary's Church, Warwick.

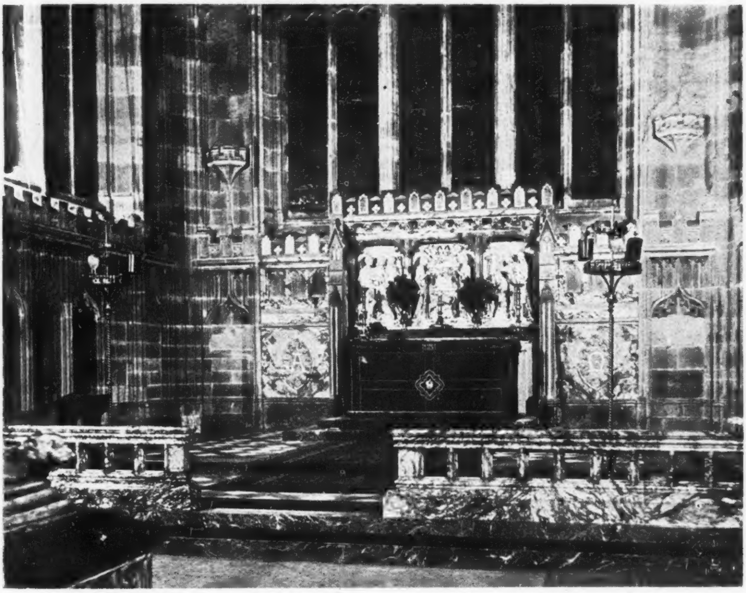

Fig. 2.—Sanctuary, St. Mary's Church, Warwick. Untouched photograph taken by artificial light. Note the beautifully clear definition of the Altar Decorations.

* Vol. ii., Jan., 1909.

St. Mary's Church, Warwick.

This is a very fine old church, built in the Perpendicular style. There are a number of societies connected with the church whose function it is to maintain and preserve the fabric. They would not allow wall attachments of any sort, and, quite naturally, insisted that the lighting equipment should not disfigure the building or interfere with the architectural details. At present only the chancel is equipped.

Scheme.—The system employed is that known as concealed lighting.

Batteries of reflectors of both metal and prismatic glass are attached to the east side of projections, such as the pillars supporting the chancel arch and the sides of the window recesses. Each battery of reflectors (there are eight altogether, containing thirty Mazda lamps) is so disposed as to concentrate the light in the required direction.

Indeed the disposition of every individual lamp and reflector was the subject of careful calculation. Four batteries (two on each side) illuminate the choir stalls, and four the sanctuary.

When it is said that the length of the chancel is 73 ft., and that only four battery positions (vertical in every case) are available on each side, it will be realized that it was no easy matter to secure even horizontal illumination therefrom.

The only actual data which I have been able to obtain is that the average horizontal illumination in the chancel is 2 foot-candles. The minimum vertical illumination is 1½ foot-candles, and, of course, this varies according to the proximity of the lights.

Figs. 1 and 2 are reproductions of untouched night photographs of the chancel and sanctuary of St. Mary's Church. Fig. 1 gives a general view of the chancel, and three outstanding qualities will be noted in the method of lighting employed. It gives practically a uniform illumination, it renders visible the roof ornamentation, and—there are no fittings to be seen.

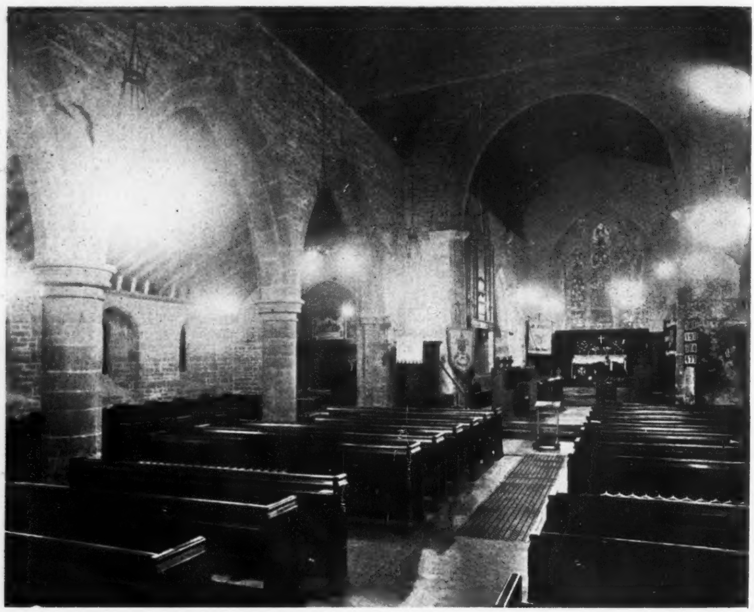

Fig. 3.—St. Peter's Church, Weston Favell, Northampton (Messrs. Law & Harris, Northampton, Architects). Untouched photograph taken by artificial light showing interior lighted by adapted wrought iron oil lamp fittings, equipped with Mazda Lamps in Holophane pines.

A closer view of the altar is given in Fig. 2, and I would draw attention to the beautifully clear definition of the decorative details. Every vein in the marble balustrade can be traced, and it is only possible to obtain such an effect by specially designing the system of illumination.

The standards visible in the photograph are old gas fittings—no longer used.

ST. PETER'S CHURCH, WESTON FAVELL, NORTHAMPTON.

This is an old country church, Gothic style, consisting of nave, one aisle, and chancel.

Scheme.—The existing wrought-iron oil lamp pendants were converted to electric light fittings, and the compromise is entirely justified by the very beautiful and appropriate results. It is impossible to see the design of the fittings from the illustrations. They are of wrought-iron filagree work, and it would have been a thousand pities to have scrapped them.

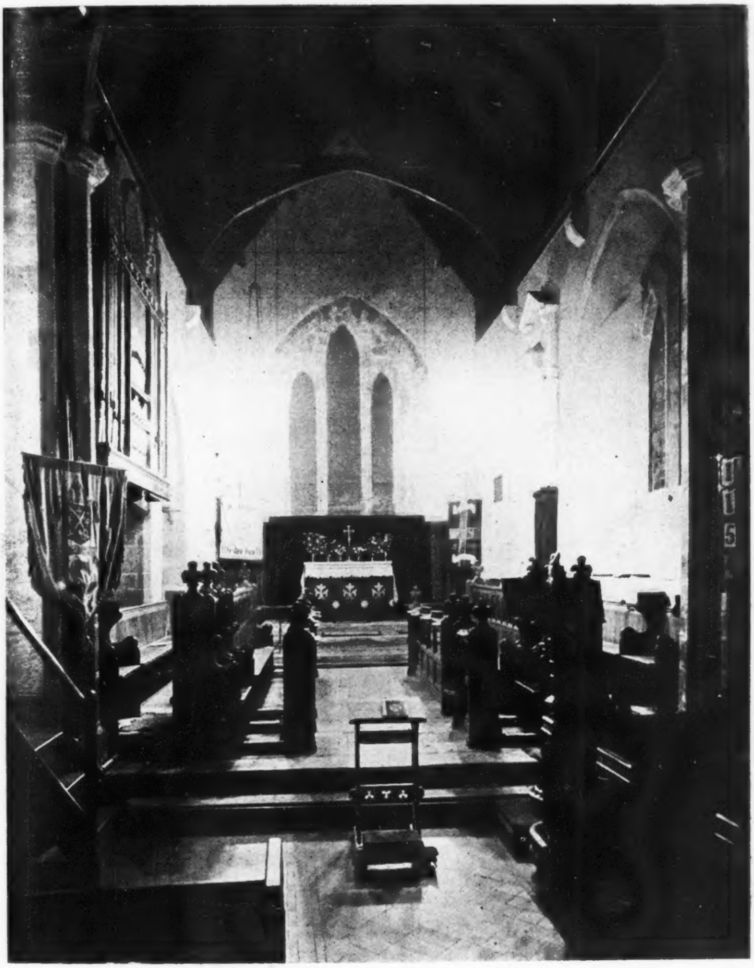

FIG. 4.—Chancel of St. Peter's Church, Weston Favell, Northampton. Untouched photographs taken by artificial light.

The nave is lighted by two rows of fittings, each carrying three Holophane

pines. Supplementary lights are given by two brackets with Holophane globes on the west wall, and the average horizontal illumination is rather more than 1½ foot-candles.

In the aisle there are four three-light fittings, equipped with Holophane pines, giving an average horizontal illumination of 1½ foot-candles.

The chancel is lighted by three four-

In the aisle there is a single row of fittings similar to those in the nave.

There is slightly higher intensity of illumination (2 foot-candles) in the chancel, which is equipped with five reflector bowl fittings—two in the choir, and three in the sanctuary.

The two illustrations of the church give an excellent idea of the uniformity of the illumination.

FIG. 5.—St. Luke's Church, Swindon. Untouched photograph taken by artificial light. Lighted with Holophane Reflector bowls containing Mazda Lamps.

light fittings, and the average horizontal illumination is slightly higher in this case, viz., 2 foot-candles.

ST. LUKE'S CHURCH, SWINDON.

St. Luke's is a new church of Gothic style in a poor district, and the first cost of the installation was of considerable importance. Fittings of simple and inexpensive design have, therefore, had to be employed.

Scheme.—The lighting of the nave is obtained from two rows of Holophane reflector bowls containing Mazda lamps. The metal portions of the fittings are finished in steel bronze. An average horizontal illumination of 1½ foot-candles is given.

ST. JAMES'S CHURCH, PENDLETON, MANCHESTER.

In arranging the installation certain conditions of cost and personal taste had to be met; but the actual result is very satisfactory, and the congregation are stated to have expressed their warm approval.

Scheme.—The nave is divided by two rows of pillars supporting arches, and from each of the arches a four-light fitting, equipped with 60-watt Mazda lamps and "I"-type Holophane reflectors, is suspended. There are sixteen fittings altogether in the nave, fixed at a height of 10 ft. 8 in. from the reference plane. The area is approxi-

mately 4,880 ft., and the average intensity of illumination, as indicated by the lumeter, is 2·5 foot-candles—not a bad result when it is borne in mind there is practically no help by reflection from walls and roof.

The chancel is lighted by two pieces of six-light striplite, facing inwards from the front, and also by two adapted gas standards fitted with bare, totally obscured Mazda lamps. It was impossible to use any form of scientific reflector on these standards, owing to the arms being insufficiently separated.

FIG. 6.—Chancel, St. Luke's Church, Swindon, illuminated by Holophane Reflector Bowls containing Mazda Lamps. Untouched photograph taken by artificial light.

CONCLUSION.

I should like to have described these church installations more fully, but considerations of space did not permit.

However, an indication has been given of several methods of church-lighting, none of which is disqualified by "glare" or "inefficiency." Each of these installations has been designed with the idea of getting adequate illumination for reading and for showing up the architectural and decorative details of walls and roof.

Where the fittings are visible they have been made to harmonize with the general scheme. In order that the illumination shall not only be adequate, but also uniform, the lamps in each case are fitted with reflectors or diffusers of scientific design. The results of these considered methods—as may be seen from the illustrations—are much superior to those of the old haphazard methods, which employed bare or improperly shaded lamps, or unscreened gas mantles.

Finally, I must acknowledge the courtesy of the British Thomson-Houston Co., Ltd., in furnishing particulars and illustrations of these four typical installations.

A New System of Stage Lighting.

By an Engineering Correspondent.

There has recently been introduced in Berlin a new system of stage lighting, the invention of the well-known scene-painter, Fortuny, which may bring about a revolution in the art of stage setting, inasmuch as it permits the correct and artistic representation of the natural effects of moonlight, sunrise, &c.

It has been the custom in the past to paint in distemper on the canvas forming the scenery the sky, clouds, trees, &c., so that they remain the same during the entire act or scene, with the possible exception of darkening or lighting the stage as a whole to represent dusk or sunrise, or showing a vertically moving circle of light through a transparent vertical strip of the background, to produce the effect of moonrise and the like. Such effects are, however, usually somewhat crude.

In the Fortuny system the entire stage is covered by a hemisphere of "matt" white muslin or its equivalent, against which the light is projected from a suitable source, and which reflects it from above on to the scenery, &c., producing an illusion of what the painters call "atmosphere." The light may first strike coloured cloth screens, producing faint rosy or other coloured effects on the stage. The projection apparatus can also throw on the hollow hemisphere the images of moving clouds, waves, &c.

The usual foot-lights and side-lights are rendered unnecessary, and, in fact, would spoil the effect if used in addition to the overhead, indirect source. The arrangement, which has been introduced in the Royal Opera House, Berlin, is being introduced in the new Comedy House in Frankfurt-on-Main, by the A.E.G. Co.

The Appeal to the Eye on the Stage.

In a recent number of *Licht and Lampe* Dr. Max Reinhardt, the well-known producer of scenic effects, is quoted to the effect that modern stage displays tend to utilise, to an ever-increasing extent, the appeal to the eye. This was strikingly exemplified in the recent "Miracle" scene in London, in "Sumurun," and other spectacular effects.

The Optical Convention.

(Held in London June 19th—June 25th, 1912.)

The holding of the Optical Convention at South Kensington was one of the most interesting events of the past month. A number of interesting papers were read. There was also a representative series of exhibits from the chief optical manufacturers in this country, and some particularly interesting loan exhibits arranged by various private owners and scientific societies. The exhibition was held in the Science Museum, and the lectures and discussions took place in the Physics Lecture Theatre of the Imperial College of Science and Technology.

The proceedings were opened by the address of the President, Prof. S. P. Thompson, D.Sc., F.R.S., who dealt with the broad development of the study of light and optics in his usual masterly manner. He traced the progress from the times of the earliest physicists, and showed how the combination of mathematical reasoning and experiment in the laboratory had led to the high degree of accuracy possible in the optical industry to-day. This, in short, is a sphere of work in which the importance of scientific method has been proved past all question.

While speaking of the work of some early investigators Prof. Thompson paused to present to the Convention a book of great historical interest. This was the first specimen copy from the printers of a translation he had made of Huyghens's original treatise —a work which had apparently never undergone translation before since its appearance about 250 years ago.

In the course of his address Prof. Thompson impressed on those present the breadth of the subject of optics. Besides the many difficult technical points in the design of optical instruments, the utilization of light for the illumination of streets, factories, libraries, &c., also involved the principles of optical science. He eulogised the work that had already been done in this direction by the newly created Illuminating Engineering Society, and alluded to the constant collaboration between the photometric laboratories at Sèvres, Charlottenburg, Bushy, and Washington in the matter of preserving a common international unit of light.

In conclusion the President made an impressive claim on behalf of greater liberality in encouraging scientific research in optics. The domain of optics was so vast that it demanded treatment as a special subject. At present no single university had created a Chair of Optics. For twenty-five years the need for an Institute of Technical Optics has been urged, but deputations to the London County Council, and questions in Parliament had met with no adequate response. The marvellous progress that had been made on the Continent during the last few years was in a great measure due to their careful fostering of scientific experiment, and if we in this country were to keep abreast of modern progress we must do likewise.

Some Papers of Interest.

With the considerable number of communications presented we can only deal very briefly. Besides his opening address, Prof. Silvanus Thompson lectured on the Trend of Geometrical Optics, and, in conjunction with Prof. E. G. Coker, presented a paper on the construction of Large Polariscopes. Prof. Stirling gave a popular and fascinating demonstration of some optical illusions, and Prof. H. H. Turner lectured on 'The Great American Observatories.'

The chief paper dealing with illumination and photometry was that by Messrs. J. S. Dow and V. H. Mackinney. The authors laid stress on the value of convenient and simple

apparatus, and showed how the Holophane lumeter, in conjunction with the new apparatus for determining polar curves used therewith, greatly simplified the work of commercial photometry. Another piece of apparatus shown and described for the first time was the Holophane portable standard of light. This consists essentially in a small tungsten lamp fed by an accumulator packed away in a convenient form of case. In order to maintain the voltage across the lamp constant irrespective of variations in the P.D. of the cell, an adjustable resistance is introduced, and a photometric device utilized comparing the light from the standard with a second small glow lamp carrying a carbon filament. When the voltage has its correct value, this photometric screen is in balance, but any variation in P.D. affects the metallic and carbon lamp unequally, and is, therefore, made evident to the user. The P.D. can then be brought back to its original value by adjusting the resistance. This portable form of standard is expected to be of considerable value as a means of checking the accuracy of illumination photometers, such as the Holophane lumeter, as well as for checking secondary standards in the commercial laboratory.

In this paper many applications of the Holophane lumeter were also described, one of the most interesting features being a diagram showing the variation in illumination during the solar eclipse of April 17th. In conclusion, the authors point out the need for greater simplification of experiments on illumination in technical colleges and the avoidance of old-fashioned apparatus and needless repetition and burdensome calculations. The series of customary experiments ought now to be supplemented by tests of modern fixtures, of the illumination of interiors by various systems of light, reflecting power of wallpapers, absorption of glasses, globes, solutions, &c., as well as the application of measurements of illumination to physical and physiological problems.

Among other interesting communications reference may be made to the contribution by Messrs. C. C. Paterson and B. P. Dudding on the Visibility of Distant Lights, an account of a method of testing the value of lights for use as signals at sea, &c.

Several contributions dealing with Colour were on the programme, including those of Messrs. A. J. Bull and A. C. Jolley on 'The Measurement of Colour,' and Mr. T. H. Blakesley and Dr. F. W. Edridge Green on 'Colour-mixing Apparatus.' Among other interesting items may be mentioned 'Optical Pyrometry' (Dr. J. A. Harker, F.R.S.), 'Some Ultra-Violet Spectra' (Mr. J. W. Gifford), and 'Errors of Observation' (Messrs. T. Y. Baker and G. B. Bryan). There were many other contributions concerned with the more purely scientific aspects of physical and photographic optics, nearly forty papers in all being on the list.

The Exhibits.

The idea of collecting together exhibits illustrative of all branches of optics was a very good one. Nothing could more aptly show the wide ground covered by the subject. The display may be divided into three sections: (1) the loan exhibits, mainly of a purely scientific character; (2) exhibits from well-known manufacturers dealing with lenses, optical instruments, and photographic work, &c.; and (3) exhibits of illuminating and photometric apparatus.

Taking, first, the loan exhibits, we may note one more instance of the great assistance rendered to the Convention by the President. Prof. Thompson had arranged in one room reproductions of all the original optical experiments of Newton, while a second exhibit in the Members' Reception Room consisted in a unique and valuable collection of old works on optics. To Prof. Stirling's collection of optical illusions, likewise collected together in one room for exhibition purposes, reference has already been made.

A striking piece of apparatus was that shown by Prof. E. G. Coker for exhibiting stresses in transparent materials under load. Various transparent

objects (spirals of glass, &c.) were subjected to a continuously alternating strain produced by a rotating shaft. Polarized light is produced by reflection from a large black glass plate, and transmitted through the objects exhibited to an analyzer composed of a pile of glass sheets. The fluctuating stresses are thus made visible to the observer on a large scale, the model being as much as 40 in. in length and 10 in. in height. One other piece of apparatus in the loan section deserving of special mention was the demonstration by E. E. Fournier d'Albe of the effect of light on selenium. The changes in electric resistance of this material when illuminated are made use of to vary the intensity of an alternating current which passes through a telephone producing an audible hum, the loudness of which depends on the intensity of the light. This arrangement, which is termed the "optophone," is suggested as a means of educating the blind to gain an idea of light and shadow and to trace the outlines of well-defined luminous objects, &c.

Photometric Apparatus.

The most interesting section of the Exhibition from our point of view is, however, that, dealing with photometric apparatus and globes, shades, and reflectors (Classes XI. and XII.). In accordance with the excellent system employed throughout the catalogue a readable introduction is provided to each of these classes, summarizing recent progress and pointing out the important position now occupied by illumination in optical science.

Many of the exhibits will be familiar to readers of this journal. Messrs. R. & J. Beck, Ltd., exhibited the latest form of Holophane lumeter, and the action of this instrument was also explained at the stall of Holophane, Ltd., in Class XII. A new and interesting departure was the apparatus for use with this instrument designed for obtaining polar curves of light distribution (now termed the Holophane Radial Photometer). The chief advantages claimed for the apparatus are: (1) It is very quickly used; (2) the polar curve is worked out while the experiment is in progress, without calculation; (3) the apparatus being portable, can be moved from room to room; (4) stray light can be allowed for; (5) one observer only is required. The possibilities of the instrument have been extended by the addition of an inclined mirror, which enables it to be used for very powerful sources of light and for concentrating and focussing forms of reflectors.

Messrs. Everett, Edgcumbe & Co. exhibited the luxometer, the Trotter illumination photometer and accessories for daylight testing, the bench photometer with combined adjustable inclined screen and flicker, and a complete photometric bench.

The South Metropolitan Gas Co. showed their apparatus for testing incandescent lamps. This utilizes an incandescent mantle surrounded by an opal chimney, and having in front of it an adjustable slot as the comparison lamp. This source is first compared with the 10 c.-p. Harcourt standard, and the slot adjusted until the comparison source has a certain convenient value. The comparison source is then turned round and compared with the lamp it is desired to test on the "double-weighing" system. An interesting addition to the bench, shown for the first time, was a device for obtaining polar curves. An adjustable arm at the extremity of which the lamp is suspended is gradually moved upwards by bevel-gear arrangement, the plane of the photometer rotating through half the angle at which light comes from the lamp tested. An interesting point is the use of a double-lever system, which keeps the lamp hanging vertically while it is being raised or lowered.

Messrs. W. Sugg & Co. showed the Carpenter Metropolitan standard Argand burner and the Harcourt 10 c.-p. Pentane standard, and also the firm's new "Radial Photometer." This is a simple device for obtaining polar curves. It consists in an elevated bar carrying a photometer and an appropriate form of secondary standard. Attached to the photometer is a bar

which rotates with it. The source to be tested is placed with its centre at the extremity of this rod, and the angle with the horizontal at which the ray strikes the photometer can be read off on a circular scale. As in the South Metropolitan Co.'s apparatus, the disc of the photometer is automatically set at the correct angle by an arrangement of levers, so as to eliminate any error due to the inclination at which the light meets the photometer screen.

The exhibit of Messrs. Alex. Wright & Co. included a model of the photometric bench in use at the Reichsanstalt, their Simmance and Abady flicker photometer, and the street photometer in which this instrument is utilized. A new feature was the exhibit of the "Dibdin's Hand Photometer." This is a portable instrument for measuring illumination, and is graduated in foot-candles. The box is 15 in. long, 5 in. broad, and 5 in. deep. The illumination is adjusted by a sliding contact varying the resistance in series with the tungsten lamp, and a small voltmeter is included in the equipment.

Globes, Shades, and Reflectors.

The most interesting feature of this display was the recognition by the exhibitors of the value of polar curves of light distribution. These are evidently coming to be regarded as essential by all companies professing to deal with illumination scientifically.

The Holophane exhibit contained a very complete series of units, full particulars of its advantages and its characteristic distribution of light being tabulated beside each specimen. Round the top of the stall various reflectors, including the new Residence type, and hemispheres, lighted both by gas and electricity, were displayed. There were several special units, such as the desk-lighting fixture, on the table, and the Uniflux reflector was fitted up to illuminate a diagram in the front of the stall. In the adjacent cases there were other exhibits, including photographs taken by artificial light of some of the most interesting Holophane installations. The diagram of light distribution of each unit was invariably given, and the use of the Holophane lumeter and the new apparatus for determining polar curves formed an integral part of the exhibit.

The Benjamin Electric, Ltd., likewise showed a variety of steel reflectors and the curves characteristic of the various units. Reference was also made to the new "daylight unit," comprising a special metal reflector and Wratten screen, which produces a visual effect similar to diffused daylight, and is intended for use in cases in which correct colour-discrimination is essential.

Messrs. J. Keith & Blackman, Ltd., exhibited a representative series of Keith inverted lamps ranging from the 150 c.-p. indoor pattern to the 4,500 c.-p. three-light high-pressure lamp. The lamps are provided with various types of reflectors, and in each instance a framed diagram of the corresponding curve of light-distribution was given.

The New Inverted Gas Lamp Co., Ltd., likewise present the curve of light-distribution of their pillar desk-light, and Messrs. W. Sugg & Co. showed two attractive new units. The "Swanley" light has a conical enamelled iron reflector, which is stated to concentrate 80–90 per cent. of the light within an angle of 90 degrees. The No. 1,730 light, with inverted conical reflector and obscured globe, gives a well-diffused light and "soft" appearance. Polar curves of light-distribution of these and other lamps were given.

The exhibit of The Union Electric Co. was designed to illustrate the uses of the Excello flame arc and of indirect and semi-indirect arc lighting. The latter systems were described, and polar curves showing the advantages of the dioptric globe for modifying the distribution of light from the flame arc for street-lighting presented. Some excellent photographs of indirect arc lighting installations were also exhibited. Among other exhibits in this section we note the "Angold" double arc lamp of the General Electric Co., the Adnil metal filament indirect lighting unit, and the semi-automatic arc

lamp of the Westminster Engineering Co. for projection work.

There are two features of this section of the Exhibition that call for special notice. In the first place, the method of grouping gas and electric lighting exhibits side by side is an interesting precedent from the illuminating engineering standpoint. In the second place, the attention paid to photometric appliances in connexion with the exhibit of illuminating apparatus, and particularly the general importance attached to polar curves of light-distribution, is surely a gratifying illustration of the spread of science among those responsible for the lighting of to-day.

A Public Museum of Lighting.

We note with interest that the Lighting Museum at Charlottenburg is, in future, to be permanent, and under the direction of the municipality. The museum appears to be on similar lines to that at Munich, previously described in these columns,* and to contain many very interesting objects showing the progress of illumination from the earliest times.

We hope shortly to give some particulars of a remarkable private collection of historical lamps and lighting appliances in this country, but we would suggest that this is a matter in which the work of private individuals might well be supplemented by the formation of a public museum of lighting, such as already exists in Munich and Charlottenburg.

* *Illum. Eng*, Lond., vol. iii., Sept., 1910, p. 539.

Prof. Dr. H. F. Weber.

It is with great regret that we record the death of Prof. Dr. H. F. Weber, who passed away on May 24th.

Prof. Weber was born in 1843, and in the course of a long and active life took a prominent part in many sections of electrical engineering. But he was equally eminent in the field of mathematical and physical science, and in his early days studied under such men as Kirchoff, Wiedemann, and Helmholtz. His researches on the theory of the incandescent lamp attracted great attention when they appeared, and are still regarded as classic at the present time.

But it is as a teacher that Prof. Weber will be best remembered. Since 1875 he had occupied the Chair of Physics and Electrical Engineering at Zurich Polytechnic. Besides being a wonderfully interesting and able lecturer he possessed in an unusual degree the power of gaining the affection of his students. To all who had the privilege of studying under Prof. Weber the news of his death will bring with it a sense of personal loss.

Colour Problems in Illumination.

By T. Thorne Baker, F.C.S., F.R.P.S.

(Abstract of Paper read before the Royal Society of Arts.)

On Wednesday, March 6th, a paper dealing with some problems in illumination was read before the Royal Society of Arts by Mr. T. Thorne Baker. After pointing out that for many practical purposes an artificial light approximating to daylight would be very useful, the lecturer proceeded to discuss some special effects of coloured lights. He recalled an experiment which showed that while the ultra-violet, violet, and orange rays seemed to produce a marked influence on bacteria, the intermediate yellow-green region had relatively little effect. Some spectro-photographs were next shown illustrating the quality of light from various illuminants, including a Sanger-Shepherd colour photograph of the spectrum of the arc. The question was also raised how far the photographic method could be applied to determine the distribution of luminosity in the spectrum, the suggestion being that a relation could be established between the density of the negative and the visual effect. Other photographs of the spectra of the mercury vapour lamp, the helium tube, and the neon tube were also shown, reference being made to the work of M. Claude on these lamps.

The use of such tubes for the detection of waves in wireless telegraphy was also mentioned, and the audience were given an opportunity of observing these lights through a spectroscope. The neon spectrum was distinguished by a very fine series of lines in the red and orange. It was suggested that possibly an approximately white light might be obtained by the combination of various line spectra; for example, the mercury vapour lamp and the neon tube. Presuming that by this means a light which appeared to the eye to be white was secured, how nearly could this be taken to be physiologically identical with genuine white light? Allusion was made to the problems of colour-vision, the Young-Helmholtz theory, &c.

Reference was made to the researches being made at the Bureau of Standards with the helium tube as a light standard. Another interesting point was the effect of frequency on the colour of the light given out by luminescent gases when subjected to a high tension alternating discharge. The red part of the spectrum in this case is in general accentuated at the expense of the violet as the frequency was increased. The presence of self-induction and capacity also affected the quality of the light.

The lecturer also referred to the work of Ives and Luckiesh in attempting to convert the light from a tungsten lamp into a close approach to daylight by the aid of a suitable light-filter. By this means, he suggested, a light closely approaching to daylight might be secured with a loss of only 2–3 per cent, and such a light would be invaluable for picture galleries, &c.

In the discussion which ensued Mr. A. P. Trotter mentioned that twenty years ago he had been interested in the question of producing a form of artificial daylight. He also referred to some of his experiments described at the last meeting of the Illuminating Engineering Society. He questioned the very low absorption of light assumed by the lecturer. Ives and others had come to the conclusion that 50 or even 70 per cent of light was absorbed in order to obtain a reasonably good match for daylight.

Mr. L. Gaster also referred to this point, recalling the data presented at the meeting of the Illuminating Engineering Society in that very room about two months ago, when a tungsten "daylight-unit" had been actually shown by Dr. Kenneth Mees. He thought there must be some mistake about the very low absorption suggested by the author, and he also understood that no combination of

sources with marked gaps in their spectra could be expected to resemble daylight closely as far as colour-revelation was concerned.

Dr. F. W. Edridge-Green referred to the physiological aspects of colour-vision, pointing out that the theory known as the Young-Helmholtz theory was now looked upon as out of date. As regards the combination of certain lines in the spectrum to secure a so-called white light, there were many people to whom extreme red lines were practically non-luminous. Clearly a result equivalent to a white continuous spectrum could not be secured in that case, and the same applied to a greater or less extent in the case of people with ordinary vision.

Mr. T. E. Ritchie commented upon the data presented by the lecturer for carbon arc spectra, pointing out that the presence of lines was largely a question of impurities, and would not be found with reasonably pure carbons.

Mr. J. S. Dow said that photographic methods of testing the colour-qualities of arc lamps should be supplemented by photometric and visual tests as had been done by Mr. Ritchie. There were several respects, notably as regards the appearance of coloured objects and acuteness of vision, in which an apparent white light made up of line-spectra would differ from true white light. He understood that the Helium light standard was still in the experimental state, and had not been adopted by the Bureau of Standards as yet. He thought that the physiological difficulties attending the use of a standard having a discontinuous spectrum might be considerable.

Mr. James Swinburne, who was in the chair, referred to the question of coloured glasses for the protection of the eyes from bright lights, and also related some experiences of an electric supply company in illuminating Billingsgate Market. A considerable amount of experimental work had to be done before they secured a light which made the fish look fresh by artificial light.

In his reply Mr. Thorne Baker explained that he had not meant to convey that combinations of line-spectra giving apparently "white" light would resemble daylight exactly in their effect on the appearance of coloured objects. The figures given for the possible minimum absorption involved in making artificial daylight were based on theoretical grounds, and intended rather to apply to arc lamps. In conclusion, reference was made to some new dyes which might be expected to play an important part in these problems.

Experiments with the Ultra-Violet Rays.

By An Engineering Correspondent.

As is well known, the human eye can distinguish directly only a small portion of the sun's rays—a comparatively narrowly bounded region of the spectrum — while there are a great number of other rays which we cannot distinguish as light. The range of our sight is confined to those rays having a wave length of between 380 and 760$\mu\mu$ (millionths of a millimeter, between, roughly, 11·2 and 22·4 millionths of an inch, otherwise expressed 0·0000112 in. and 0·0000224 in.), whereas much longer and much shorter rays have been registered.

Just as our retina is sensitive to only a comparatively short range of rays, so also are all materials in this respect limited to only a portion of the spectrum's rays, and, as a rule, their ranges are not co-extensive with those of our vision; so that they furnish proof of the existence of rays which we cannot "see." The materials which we use in photography are especially sensitive to those rays which are very strongly refracted. With their assistance Ritter, in 1801, discovered the invisible "ultra-violet" rays; since then, photography has offered a means of more exact research as to the nature of the ultra-violet spectral regions.

Dr. H. Lehmann reported very

fully, at the eighty-second meeting of German Physical Experimenters and Physicians, upon some very interesting results of his researches into the character of these rays. His experiments were made with a self-made or self-improved ultra-violet "filter," with nitrosodimethylanilin as colouring matter. This substance is permeable for rays the length of which lies between 280 and $400\mu\mu$; besides these, some other rays from the visible spectrum passed through. These were rendered —at least in the main—harmless by combining with the nitrosodimethylanilin filter a layer of Jena "blue uviol" glass. In using sources of light containing considerable red one is compelled to introduce a third component, and for this purpose an aqueous solution of copper sulphate is very suitable. As a matter of fact, such a filter, when used with a very strong source of light—as, for instance, an electric lamp—lets through traces of green and violet; but for all that, these "adulterants," the intensity of which is only about 1-1000th that of the ultra-violet rays, do no damage.

Especially interesting are the effects of fluorescence which are produced by the ultra-violet rays, as Dr. Lehmann was able to show very plainly with the help of his filters. The number of these phenomena is exceptionally large, but they do not ordinarily appear, because they are too weak and are hidden by the light.

There are but few substances which when acted upon by the ultra-violet rays do not shine; for instance, porcelain and the metals, when the latter are free from oxide. Nearly all other materials, the human body not excepted, are more or less strongly fluorescent. If a paper or linen screen be placed in the cone of ultra-violet rays in a dark room, this will radiate bluish-white light. That this is not the "colour" of the ultra-violet rays, but of a secondary nature—that is, fluorescent light—is proved by the fact that if a sheet of white porcelain is placed before the paper or linen screens the porcelain does not shine similarly, but appears to be covered with black velvet.

Marked fluorescence, or else phosphorescence, under the influence of the ultra-violet rays, is shown by the following substances: æsculin (blue), uranin (green), rhodamin (red), Jena didymium glass (rose red), rubin (strong red), platinum cyanide compounds (very marked green), and zinc sulphide (very marked greenish white). If a hard-boiled hen's egg, cut through the middle, be brought into the path of the ultra-violet rays, the outer shell shines reddish-white, the skin bluish-white, the albumen, or "white," citron-yellow, and the yolk dark yellow. A veal cutlet presents the following appearance: the muscle tissues are dark brownish red, the gristle an intense blue-violet, the bones whitish-blue, the fat yellow, the sinews and skin whitish, &c. Living human beings show the fluorescence very markedly: the hands shine whitish-blue, but varying according to the "complexion"; dark hair shows grey, almost white; the lens and cornea of the eye and the natural teeth bright whitish-blue. But false teeth, which are usually composed of a kind of porcelain, appear black. The ultra-violet rays can also betray the presence of rouge or other artificial preparations on the skin. The rays can also be made use of to distinguish real from artificial precious stones.

Each type of glass has a certain fluorescent colour. The fluorescence of paraffin wax is interesting, as the entire mass shines with an intense blue light.

According to the *Photographische Rundschau* the luminescence can be of practical use in analysis. Chemically pure substances show, as a rule, no luminescence, or at best very slight, and this throughout the entire mass. The appearance of such phenomena and their character depend upon the manner of manufacture of the substances—that is, different "makes" of the same material can act differently. Impure materials shine, as a rule, very strongly, but this strong luminosity shows itself only with single crystals or groups of crystals.

The luminescent analysis can be applied in mineralogical and botanical research.

The Ideal Home Exhibition.

BY AN ENGINEERING CORRESPONDENT.

In an "ideal home" good illumination should surely be an important item. At the exhibition which has recently terminated at Olympia there were a number of exhibits dealing with lighting matters.

A feature was the number of firms exhibiting plant, acetylene, electric, and petrol-air gas. The South Metropolitan Gas Co. had also a large stall illuminated round the roof by burners in Holophane glassware. The "Metro" burner received much attention, and there were also demonstrations of gas heating appliances. The British & Colonial Syndicate Lighting Co. exhibited the Simpitrol petrol-air gas plant, and plant of this kind was also shown by County Light, Ltd., and Messrs. Strode & Co. The advances in convenient automatic electric lighting sets were exemplified at the stalls of Messrs. Duncan Watson & Co., Strode & Co., Edmundson's Electricity Corporation, and R. A. Lister & Co., Ltd. In the "Lister-Bruston" automatic system the chief feature is the avoidance of the necessity for a large storage battery, the voltage being automatically regulated according to the load, and a device employed to start the engine immediately a light is turned on. The Foster Engineering Co. exhibited "Foster" metal lamps and gas governors, and the Allen Liversidge and Allen Acetylene Cos. had an excellent display of portable and table acetylene lamps.

It may be noted that quite a number of the firms mentioned are interested in several distinct methods of illumination. The display of plant running smoothly before the eyes of passers-by was an excellent object lesson, and it was satisfactory to see that the exhibition of masses of naked lights was in general avoided, and that the utilization of shades was not forgotten. This is a point which may be insisted upon, for the general public are naturally disposed to use lights in the same way as they are seen on exhibition. Some of the groupings of silk shades were quite effective.

Turning next to the stalls devoted to other purposes in the exhibition, it may also be said that the tendency was, on the whole, in the pleasing direction of more subdued lighting than we have sometimes previously encountered in exhibitions. In some cases decorative shades were effectively utilized in mass —for example, in the Bird's Custard Exhibit and Restaurant (where an impression of evening sunlight—possibly accidental—was also produced by the light from the flame arcs above filtering between the beams and foliage of the roof). The number of examples of unscientific lighting was, however, still too many, but there were several instances in which Holophane reflectors and the B.T.H. "Eye-Rest" system were used with advantage. In many of the furniture exhibits tasteful, subdued lighting effects were obtained, but it was sometimes surprising to notice the lack of any agreement as to the methods of lighting suited to a certain style of decoration; for example, a massively decorated room in a dark style would, in one case, be flooded with light from crystal chandeliers, and in another heavily silk-shaded lights and very dim illumination used. More might doubtless have been done in the direction of employing for the lighting of a stall lamps which harmonized with the actual exhibit. It is singular how often simple modern pendant opal shades and naked electric lamps are still used to illuminate old furniture, and examples of this are often seen in curiosity and old furniture shops in London

An attempt in this direction was made in the exhibit of Oriental carpets, &c., by Messrs. Treloar & Sons, lamps in Eastern style, corresponding with the exhibits and the design of the

stall, being employed. There was also a small dome decorated internally in blue and illuminated by concealed lights.

As regards the ideal house itself, it must be owned that, however good the design of the building and the facilities provided in other respects, the lighting could not be described as ideal, and the same applies to some other model rooms on view. One met with imperfect methods of shading which allowed the filament to be exposed to the eye and were of little service in concentrating the light, and not infrequently sufficient care had not been exercised to see that the light was distributed in the best way. Adequate illumination is surely quite as necessary to the householder as good furniture, hot and cold water, or proper sanitary appliances, and one may venture to hope that in the next "Ideal Home" pains will be taken to bring the lighting more up to date.

Perhaps the most original decorative fixtures for lighting were to be seen in the exhibits of modern Dutch, French, Belgian, and English furniture in the gallery. In the French suite, for example, a child's room, library, bedroom, studio, dining-room, &c., were arranged and lighted. In one case the light was derived from a single bronze central fixture studded with a ring of frosted miniature lamps. In another instance inverted lighting from a curiously designed horn receptacle was employed, and in yet another room the light was placed within a vessel of orange glass, having somewhat weird effect. Perhaps, however, the most original system was that in a drawing-room decorated entirely in artistic blue and green. This was lighted by a central inverted fixture consisting of a tinted blue-green china bowl, the colours of which were strongly brought out by the transmitted light, and harmonized with those of the general scheme of design. A second bowl of this kind stood on a pedestal in one corner, and likewise directed its light on the ceiling.

A word or two may be said about another exhibit in the galleries, the "Virol" Babies of All Nations, who were to be seen disporting themselves in the quaintly designed Eastern courtyard which served as a nursery. Here the lighting was evidently designed with a view to throwing a certain glamour over the proceedings, the corridors through which the public passed being dimly lighted by lamps concealed in green shades, while the nursery itself was more brightly illuminated by lamps of larger candle-power placed within bizarre silk shades and hung high up near the ceiling.

In the Dutch Village some good examples of the Dutch style of fixture design were to be seen, but the village itself offered an opportunity for spectacular lighting of which better use might have been made. The beds of gorgeous tulips would probably have appeared to greater advantage had the illumination been stronger. An attempt was made to illuminate the background scenery by rows of concealed incandescent lamps placed near the top of the canvas, but as these were not equipped with any form of reflector designed to produce even illumination, the result was somewhat patchy, the portions nearest the lamps appearing far brighter than those on the eye level.

The possibilities of special illumination as a spectacular aid in displays of this kind do not seem to be yet sufficiently appreciated, and one may hope for an advance in this direction in the exhibitions of the future.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

The Necessity for Scientific Reflectors.

This is the title of a new folder issued by **The British Thomson-Houston Co., Ltd.** (77, Upper Thames Street, London, E.C.).

It covers the well-known Holophane (glass) and Mazdalux (metal) reflectors supplied by the Company. In addition to the usual data and prices of the reflectors, the folder also contains an interesting account of the need for, and value of, a scientific reflector. By re-directing the light in a definite manner, the reflector increases the useful illumination; and by hooding the lamp and diffusing the light therefrom, it obviates "glare."

Both Holophane and Mazdalux Reflectors are accurately and scientifically designed to give definite, pre-determined light distribution.

The accompanying illustration shows the design of the cover of this folder.

The B.T.H. "Eye-Rest" System.

We have on previous occasions referred to the value of indirect illumination, a notable example of which is **The British Thomson-Houston Company's** "Eye-Rest" system. In principle the "Eye-Rest" system is similar to other indirect lighting systems—that is to say, the light from the lamp is first thrown on the ceiling, which in turn reflects it down on to the working plane.

The fittings consist of upturned reflectors in ornamental metal or plaster bowls suspended by chains from a ceiling-plate. A very efficient reflector is used in the fittings, made of silvered glass, with spiral corrugations which effectually correct any striation of the light. The bowls are made in various sizes to take one or more 60–100-watt lamps, each lamp having its separate reflector. Our illustration shows a 10-in. moulded composition bowl.

The illumination given by these units, assuming that they have been provided with reflectors of correct distribution, and are suspended at a proper distance from the ceiling, is extremely good.

We have received from the British Thomson-Houston Co. a neat little folder giving particulars of their "Eye-Rest" system mentioned above. In addition to giving full information regarding the different styles, finishes, and prices of the fittings, it reproduces some photographs of existing installations of indirect lighting, and clearly emphasizes the special advantages to be gained by using this system.

Holophane Tungsten Units on the Central London Railway.

It will be recalled that we referred some months ago to the lighting of one of the stations on the Central London Railway by means of "One-Watt" Lamps and Holophane Reflectors.* We are informed by **Messrs. Siemens Bros.' Dynamo Works, Ltd.** (Tyssen Street, Dalston, London, N.E.), that the whole of the station lighting on that railway is now carried out in this way with modern "Wotan" lamps, and that there are altogether some 500 points installed. This indicates the considerable development that has taken place in this system of lighting, which, it will be remembered, was shown to be extremely uniform and efficient in the recent discussion on Railway Lighting at the Illuminating Engineering Society.

Tantalum Traction Lamps.

Messrs. Siemens Bros. also inform us that Tantalum Traction Lamps are to be installed on another well-known East London tramway. These lamps are now installed on nine-tenths of the London tramway systems, and 20,000 are actually in use on the L.C.C. cars alone. This illustrates their suitability for this class of work, and shows that they are giving real satisfaction.

High Voltage 10 and 16 c.p. Lamps.

Messrs. Siemens now inform us that they are in a position to supply stock orders for 200–250-volt "Wotan" lamps in 10 c.-p. sizes as well as 16 c.-p. The price of the 10 c.-p. lamp has been fixed as follows: 3*s.* 6*d.* for pear-shaped bulbs, 3*s.* 9*d.* for round bulbs.

A large demand for these lamps is anticipated for use in private houses for bedrooms, &c.

Street Lighting by Magazine Flame Arc Lamps.

The General Electric Company (67, Queen Victoria Street, London, E.C.) inform us that they have received an order from the Dundee Corporation for eighty of their well-known Angold Magazine Flame Arc Lamps for street lighting. This order was placed after the lamps had been subjected to severe tests extending over several months.

The Sunderland Corporation has also placed an order for twenty-eight similar lamps, this being the third repeat order received from them by the G.E.C. during the past nine months.

* *Illum. Eng.*, Lond., Jan., 1912, p. 46.

Catalogues Received.

Messrs. Siemens Bros.' Dynamo Works, Ltd. (Tyssen Street, Dalston, London, N.E.), have sent us a copy of their latest price-list of Holophane Glassware, which deals with all the types now obtainable, including also the Holophane Benjamin Steel Reflectors, to which we have previously referred in these columns.* There is also included in this new edition (in the centre of p. 19) an entirely new type of Household Holophane Glass Reflector, which is said to be very effective on the ordinary type of electrolier largely used in private houses.

The British Thomson-Houston Co. (77, Upper Thames Street, London, E.C.) have just issued a price-list of their Mazda Automobile Lamps, covering lamps for headlights and rear-lights, and tubular and festoon lamps for interior lighting. These lamps range in size from 1 to 32 c.-p., and in voltage from 2 to 12 volts.

With reference to the article on Church Lighting in this issue, **The British Thomson-Houston Company**, who designed the installations in each case, and the contractors who worked to their specifications are to be congratulated on the excellent results obtained.

The installation at St. Mary's Church, Warwick, was carried out by Mr. Alexander Wylie, Warwick; that in St. Peter's, Weston Favell, Northampton, by the Northampton Electric Light & Power Co.: and those in St. Luke's, Swindon, and St. James's, Manchester, by Messrs. Hutton Bros., Swindon, and Messrs. John Collier & Sons, Manchester, respectively.

A New Hand Lamp.

Messrs. Krupka & Jacoby (11, Queen Victoria Street, London, E.C.) have put on the market a unique design of Hand Lamp known as the "Bayly" lamp. Among other special features, the design ensures that no strain can come on the flexible owing to the method of attaching the braiding, and there is no risk of breakage through the lamp toppling over, on account of its special shape.

We are informed by the **British Westinghouse Electric and Manufacturing Co., Ltd.** (Trafford Park, Manchester), that amongst other plant recently ordered by the South-Eastern & Chatham Railway Co. are 144 Westinghouse 10-amp. 45-hour Magazine Flame Arc Lamps.

* *Illum. Eng.*, Lond., Jan., 1912, p. 44.

Metal Filament Lamps for Railway and Tramway Lighting.

The following extract from the London *Times* of March 13th, 1912, gives interesting information on the use of metal filaments for traction cars :—

"THE UNITED STATES.

"TESTS OF ELECTRIC LAMPS.

"During the summer of 1911 the Interborough Rapid Transit Company conducted exhaustive tests with several types of high-efficiency incandescent lamps, and as a result they have equipped the 780 cars used in the subway express service with wire-drawn tungsten lamps. For the purposes of the test 500 lamps, including....the wire-drawn tungsten types, were installed on cars operated in the regular service...The lamps were inspected every day, and all those burnt out or broken were carefully recorded before being renewed....The comparative life of the test lamps was calculated on the basis of the percentage of lamps still in service at the end of each 100 hours of burning....

"The tungsten filament lamps gave the best results. A few lamps with poor filaments failed very quickly after they were put in, but about 65 per cent had a life of 1,000 hours or more."

The tungsten lamps referred to in the test are the drawn-wire Mazda lamps, traction type, giving about 20 c.-p. with 25 watts consumption, similar to those the B.T.H. Co. are supplying for use on railways and tramways in Great Britain.

The use of traction lamps is constantly increasing in tramway and railway service since the drawn-wire filament has made lamps durable and suitable for the conditions of such service.

The "Strand" Mantle.

A new type of INVERTED GAS MANTLE has recently been introduced by the **Strand Mantle and Machine Co., Ltd.** (121, Bollo Bridge Road, Acton, London, W.), and is manufactured on special machinery devised and patented by Mr. J. I. Robin. The mantle differs from the ordinary inverted mantle chiefly in the fact that it has not a fixed, rigid shape, but is formed of loose, flexible strands, which shape themselves to the form of the flame in the particular burner for which they are used. The mantle is not collodionized, and the free ends are brought together at the bottom and tied so as to leave a small aperture around which the flame licks.

In the manufacture of the mantle a large economy of labour has been effected by the ingenious design of the machinery. The mantles are continuously formed on a long, revolving rod, and very little is left to the operator except the tying off of the ends.

Among the claims put forward for this mantle may be mentioned its safety from damage in transit and its economy in gas consumption, due to the accurate shaping of the mantle to the flame.

Some Publications Received.*

Die Fortschritte des Beleuchtungswesens und der Gasindustrie. By Prof. Dr. H. Strache.—A record of progress of the gas industry in Germany during the year 1911, containing references to many new developments in illumination.

Bulletin of the Industrial Commission of Wisconsin.—This contains a list of twenty general rules for preserving safety in works.

The Origin of Radium.—By Frank Soddy.

Vital Effects of Radium and Other Rays. By Sir James Mackenzie Davidson.—Both of the above are reprints of proceedings at the Royal Institution of Great Britain.

Electrical Experiments with Mercury contained in Tubes.—By J. H. Vincent.—A paper dealing with various luminous effects produced by the mercury arc under special conditions.

The Physical Review.—The issue for May, 1912, contains a paper on 'The Radiant Efficiency of Incandescent Filaments,' by W. E. Forsythe.

We also have to acknowledge the receipt of the following: *Journal of the Royal Sanitary Institute, Journal of the Royal Society of Arts, Journal of the Society of Architects, Journal of the Western Society of Engineers, University of Illinois Bulletin, American Chemical Journal, Proceedings of the American Academy of Arts and Sciences, Proceedings of the Tokyo Mathematico-Physical Society, Bulletin of the Societé Imperiale des Naturalistes de Moscou Zeitschrift fur wissenschaftliche Photographie Photophysik und Photochemie, Atti della Associazione Elettrotecnica Italiana.*

*** To many of these we hope to refer in greater detail shortly.**

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

A somewhat interesting item in the London papers has been the report of the oculist whose advice was requested on the **Lighting of the House of Commons.** It is proposed to substitute metallic filament lamps and Holophane glassware for flat-flame gas burners. The question was raised whether they would give rise to any degree of glare, but it was pointed out that the lamps would be covered by suitable prismatic glassware placed above the obscured glass roof, as at present, so that there would be no material change in this respect.

In the United States discussion still proceeds on **Direct and Indirect Lighting.** At a recent meeting of the Illuminating Engineering Society in that country a series of papers on this point were presented, and there are also articles by VAUGHN and HADLEY (*Elec. Rev.*, N.Y., June 1 and 15), describing recent installations. According to the former, the specific consumption in rooms so lighted is about 0.4–0.6 watts per lumen.

A writer in *The Electrical Review* of London deals with tungsten indirect lighting and describes several forms of silk shades adapted for the purpose.

W. KLEIN (*Gesundheits-Ingenieur*, No. 15, 1912) contributes an article summarizing work carried out on the **Ultra-Violet Rays** and their effect on the eyes; the paper is accompanied by a complete list of references. M. LUCKIESCH also describes some researches on this point (*Elec. World*, June 15). He gives photographs of various spectra and an interesting diagram comparing the transmission throughout the spectrum of clear and Euphos glass. It is interesting to note that the illumintaion required to produce a certain photographic effect from tungsten lamps, carbon arc lamps, and daylight are found by him to be in the proportions of 15, 1·5, and 1. The same author describes some tests on **Direct Reflection from Shiny Paper,** showing the value of indirect and well-diffused direct systems of lighting for the purpose of avoiding this defect.

Licht und Lampe contains several interesting articles. R. FURSTENAU discusses **Light as a Curative Agent**, and describes the Finsen lamp, the use of uviol mercury vapour tubes and other specialities. There are also some well-illustrated descriptions of recent forms of fixtures, including a type made of marble and apparently giving a distinctly striking effect.

ELECTRIC LIGHTING.

In electric lighting there are not very many communications to record.

F. J. BRISLEE (*Electrician*, May 31) contributes an illustrated article on the **Changes in Metallic Filaments** during life. He finds that all such filaments tend to become crystalline in course of time, but the effect is less noticeable in some forms than others. The problem is to make the period necessary for crystallization to set in longer than the normal useful life. E. J. EDWARDS describes researches on the "over-shooting" of tungsten lamps, but fails to find any sign of an abnormal momentary rise in candle-power; he mentions that his conclusions are confirmed by LUCKIESCH.

C. SIREY (*Electricien*, June 8) discusses the legal situation involved in cases in which consumers substitute lamps of higher candle-power than that prescribed in their agreement with the lighting company. When only carbon lamps were available the situation was simple; but the substitution of metallic lamps for carbon ones makes it more complicated.

M. SOLOMON, in a paper before the Institution of Electrical Engineers, discusses **Flame Arclamps.** He gives the carbon costs for several varieties and the latest figures for the consumption, which varies, in different types of lamps, from 0·1 to 0·16 watts per mean hemispherical candle-power. W. WEDDING (*E.T.Z.*, June 6th) describes a new form of **Three-Phase Arclamp**, and believes that the difficulties connected with such lamps are overcome in this example. The lamp uses three inclined converging flame carbons. It is stated that a long arc is used, that the carbons waste away less quickly than in most flame arcs, and that a specific consumption of 0·1 to 0·2 watts

per mean hemispherical candle-power is obtained.

GAS, OIL, AND ACETYLENE LIGHTING.

An important event of the past month has been the **Annual Meeting** of the **Institution of Gas Engineers** in London, but there were no papers dealing specifically with lighting. The address of the President included an interesting review of the year's progress, in the course of which allusion was made to the possible economies to be derived by adjusting the quality of gas. A case was mentioned in which the illuminating power had been reduced from 12·77 to about 2, and the calorific power from 600 to 553; but, nevertheless, the new gas gave an *increased* light with an incandescent burner, 73·7 instead of 64 c.-p. being obtained with 3.5 cub. ft. per hour.

Among other contributions we note the remarks of V. R. LANSINGH (*Prog. Age*, June 18) on **Standardisation of Gas Lamps,** which is commented upon in *The Journal of Gaslighting* (May 28). The The author advocates more definite methods of rating gas lamps, the presentation of polar curves, and the study of forms of globes and reflectors, increasing the percentage of light in a downward direction. He also desires the dimensions of holders for globes, &c., to be kept to certain standard dimensions similar to those agreed upon for electric lamps. The paper also contains a general review of recent progress. The **Value of Polar Curves** of light-distribution is also emphasized by a series of diagrams published for the Keith lamps showing the effect of various forms of reflectors (*J.G.L.*, May 28; *G.W.*, May 25.)

Attention may next be drawn to an interesting note on workhouse lighting, the point in dispute being the **Comparative Costs of Petrol-Air and Coal Gas;** figures from Scott Snell, O'Connor, and other authorities on this point are quoted. The costs of electricity, petrol-air gas, and acetylene also figure in a recent article in *Acetylene*.

In *The Journal of Gaslighting* (May 28) a new form of **Electrical Ignition**—the "switch-on" system—is described. A feature is the compact form of battery, which is packed away within the space of an ordinary electric switch. A highly novel suggestion alluded to in the same journal is that wireless waves should be utilized to turn on and off lamps in the street, and it is stated that the method is being actually developed in France.

An interesting development of high-pressure gas lighting (*J.G.L.*, June 11) occurred at the Crystal Palace, the lamps being employed to illuminate the figures in a pageant by night. They were assembled together between the arena and the audience, and flanked by suitable reflectors screening the eyes of the observers and directing the light on the display.

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Lighting of Workhouses (*J.G.L.*, June 25).
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A Review of Various Lighting Systems (*Acetylene*, May ; *Country Life*, April 27).
The Dangers of Illuminants (*Acetylene*, May).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
G. W.—*Gas World.*
J. f. G.—*Journal für Gasbeleuchtung.*
J. G. L.—*Journal of Gaslighting.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

REVIEWS OF BOOKS.

Light, Visible and Invisible. By Silvanus P. Thompson, D.Sc., F.R.S., Principal of the City and Guilds Technical College, Finsbury. (Macmillan & Co., Ltd., St. Martin's Street, London, 1910.)

This is an enlarged edition of the well-known book by Prof. Thompson, containing originally the series of popular lectures delivered at the Royal Institution at Christmas, 1896. The illustrated description of the experiments on visible and invisible light makes as fascinating reading as ever, and to these Prof. Thompson has now added a chapter devoted to radium and an account of his lecture on 'The Manufacture of Light,' given before the British Association at York in 1906. The illustrations throughout are excellent, and the explanations are of the lucid and popular character which we always expect from Prof. Thompson. The treatment of the wave-theory of light and the explanation, by many ingenious explanatory models, of the nature of interference and polarization are perhaps particularly interesting.

In the last section of the book, dealing with 'The Manufacture of Light,' a considerable amount of ground is covered. The processes of photometry and the distinctions between luminescence and incandescence are simply explained, and diagrams due to Langley, Rubens, Wedding, and others are presented, showing the distribution of energy in the spectra of various illuminants. In conclusion, it is computed that in Great Britain from £10,000,000 to £20,000,000 is expended annually in the process of producing light from coal, and that of this immense sum probably as much as 99 per cent is frittered away in producing heat and other non-luminous vibrations. There is, therefore, room for vast improvement in our methods of producing light, and it is difficult to conceive of a more fruitful or fascinating field for study.

A Practical Treatise on Light. By R. S. Clay, B.A. (Cantab.), D.Sc. (Lond.), Principal of the Northern Polytechnic Institute. (Macmillan & Co., Ltd., St. Martin's Street, London, 1911.)

In the introduction to this work the author lays stress on the remarkable recent advances in the manufacture of optical and scientific instruments, three-colour work, dyeing, &c., all of which demand an advanced knowledge of the theory of light. He has therefore sought to collect together an unusually comprehensive series of experiments in optics, and the present work is an extended edition of his earlier work entitled 'Practical Exercises in Light.' The scope of the book will be gathered from the fact that it occupies over 500 pages. There are also over 400 diagrams and illustrations, which are invariably well executed and distinct.

The first five chapters are devoted to simple experiments with pins and familiar work with prisms, lenses and mirrors, and the spectroscope. Subsequently the author breaks more difficult ground in treating the optical bench, compound lenses, interference and diffraction gratings. The advanced student will also find much material for study in the treatment of the microscope and the interferometers. The remaining portion of the book deals exceptionally fully with some branches of optics not usually noticed to any great extent in these text-books, such as 'Photometry,' 'Colour-measurement' and 'The Eye and Vision.' It will be admitted that these subjects ought to receive fuller treatment than they usually do, and the author has set a good precedent in this respect. We should, however, like to see the subject of photometry dealt with more fully in a subsequent edition, and we notice that very little is said about the measurement of illumination.

The book is one which may be specially commended to the advanced student who has already a good theoretical grounding in optics. It is necessarily somewhat condensed, but contains an exceptional variety of experiments, and will therefore doubtless prove a useful and suggestive guide to those engaged in teaching these subjects.

Elektrotechnische Winke für Architekten und Hausbesitzer. By L. Bloch and R. Zaudy. (Julius Springer, Berlin, 1911; mk. 2.80.)

The rapid development of industrial and domestic applications of electricity has forced the general public to take a more intelligent interest in these matters, and the subject also comes very frequently within the province of the architect. The authors have therefore written a short popular treatise of about 150 pages on this subject, with a view to keeping architects and the public informed of what is now being done.

The initial part of the book deals briefly with wiring and the arrangement of circuits. Plans of typical lighting installations are shown, and it may be noted that the elaborate series of symbols of the Verband deutscher Elektrotechniker for switches, boxes, meters, &c., is given and used. There are also illustrations of concealed methods of wiring, hidden distribution boxes, and methods specially applicable to old mansions. A condensed account of progress in electrical illuminants is next given, and the authors then proceed to discuss in popular style various methods of interior electric lighting. The use of imitation candles, lamps distributed on the ceiling, and indirect and cornice lighting are successively touched upon, and something is also said regarding shop- and sign-lighting. The final pages of the book are devoted to electric heating and the various modern applications of electric power (centrifugal pumps, cranes, drilling machinery, &c.).

Iron and Steel Institute.

The Autumn Meetings of the Iron and Steel Institute will be held at Leeds, on Monday, Tuesday, Wednesday, Thursday, and Friday, September 30th and October 1st to 4th, 1912.

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ELECTRICITY · ACETYLENE · OIL · GAS

The ILLUMINATING ENGINEER

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EDITORIAL.

Measurement of Illumination in Factories.

In this number we are able to give a somewhat fuller account of Mr. D. R. Wilson's series of tests on the Illumination in Factories* (pp. 380-84).

One of the most striking things in this report is the evidence it affords of the growing recognition of the value of simple measurements of illumination carried out on the spot. In general the measurements were carried out in a horizontal plane about forty inches from the floor, but in special cases the tests were made at the spot (such as the slanting case of the compositor's frame) where the work was actually carried on.

In connexion with artificial illumination, we are glad to notice, special emphasis is attached to the avoidance of glare. It is most remarkable how in the course of a few years this idea has taken root. To-day one of the strongest arguments that can be brought by manufacturers of lighting appliances in support of their system is that it provides for the comfort of the eyes; a few years ago such claims were almost invariably based on the question of cost. This change in view has been almost entirely brought about by the illuminating engineering movement. The very word "glare," in its present accepted sense, was practically coined at the meetings of the Illuminating Engineering Society in London about three years ago.

As regards daylight illumination it is interesting to see how high are many of the values recorded by Mr. Wilson in comparison with those commonly met with in schools, offices, &c. The fact is that the highly organized cotton industry, recognizing from the first the immense value of sufficient illumination, has adopted buildings

* Referred to in our last number, p. 330.

specially designed for the maximum admission of daylight. Artificial illumination has been somewhat neglected, but we believe that this, too, will now be the subject of equally careful supervision.

As regards the amount of illumination required for various processes Mr. Wilson wisely refrained from making any hard and fast recommendations at present, and confines himself to giving a general idea of the values which prevail at present. He draws a useful distinction between "inspective" (meaning thereby processes which involve the continuous application of the eyes to one point or small area), and "detective" work, which merely necessitates keeping a general watch, actual labour being demanded only when some fault occurs. One naturally finds that quite a different order of illumination is required in these two cases, and possibly a rough classification on this basis might be made. There are, however, many other points which must be considered in fixing the necessary illumination — for example, the reflecting power of the material used. It is interesting to notice that the illumination provided for linen weaving is almost invariably higher than in the cotton weaving processes; the reason being that the amount of light reflected from the material used is about 30 to 40 per cent. in the one case as compared with 60 to 80 per cent. in the other.

We strongly advise all those interested in factory lighting to read this report, and we have no doubt that the information it contains will be most useful to those engaged in framing a standard of illumination in the future.

In conclusion we may also note that Mr. D. R. Wilson, in terminating his report, refers to the aid given in these researches by Mr. G. F. Sedgwick, H.M. Inspector's Assistant, who is also responsible for the sketches of typical methods of lighting accompanying the report.

The Colour of Artificial Illuminants.

The method of examining the colour of artificial illuminants described by Dr. W. Voege in this number (pp. 375-379) has the merit of simplicity. It has suggested itself to the author as a result of Mr. Ritchie's paper on this subject. Mr. Ritchie, it will be recalled, utilized several distinct methods of analysis, namely, visual impression, analysis by the "tintometer," measurements of the reflecting power of coloured materials, and photographic records with special colour-sensitive plates.

The spectro-photometric comparison of sources has the approval of Dr. Mees, Dr. Ives and other authorities. It would seem that to reproduce side by side the spectra of the two illuminants to be studied, and to compare their intensity colour by colour throughout the visible range, would be one of the most accurate methods of analyzing the colour of illuminants and comparing them with daylight. On the other hand, the spectrophotometer is an elaborate and relatively expensive form of apparatus and needs skilful handling. It is also occasionally not very easily applied to the analysis of coloured fabrics owing to the fact that the amount of light reflected from some dark materials is so small.

Dr. Voege has therefore adopted a somewhat simpler device. This consists in merely making an ordinary photometric comparison but observing the field in the photometer through a series of coloured glasses corresponding with the various regions of the spectrum. Presumably, one cannot divide up the spectrum so exactly in this way—it is, for example, notoriously difficult to make a screen which will transmit only the yellow — and the results might therefore only apply to a particular set of glasses. But it is suggested that an approximate idea can readily be gained as to the degree of resemblance of artificial illuminants

to daylight, and Dr. Voege has tabulated an unusually complete series of results obtained by this means.

Dr. Voege's method is one that can easily be reproduced. We hope that his interesting article will stimulate others to make similar researches. We are glad to think that the experiments recently carried out have gone some distance towards removing erroneous impressions, but we should like to see further confirmatory evidence obtained by different observers and with various methods. It is surely time that the conflicting statements made on this subject of colour should be investigated, and the matter finally cleared up.

Lamps from the Earliest Times.

By the courtesy of Mr. J. W. Johnston we are able to give in this number some particulars of his interesting collection of old lamps. This comprises specimens from many different countries, some of them of a very primitive kind, others more elaborate and ornate.

On examining many of these early lamps the observer is at once struck by the fact that their design apparently remained substantially the same over an immense period of time. Take, for example, some of the primitive clay lamps coming from Egypt and other countries in the East. One of these, in Mr. Johnston's collection, is estimated to have been in existence in 4777 B.C., and many of the others date from 200 B.C., or earlier, up to a few hundred years A.D. Yet the principle of these lamps, the use of simple wick in a dish of liquid fat or oil, is almost the same. It is only through small details in the ornamentation that we are able to recognize the great difference in antiquity.

Contrast this slow rate of progress with the extraordinary changes in illumination that have occurred in the last ten years! Not only have remarkable improvements in some forms of lamps taken place but entirely new methods of illumination have made their appearance. We have seen in this short period the development of the metallic filament lamp, the flame arc, the inverted mantle, high-pressure gas lighting, electric vapour lamps, and other novelties. There can be no question but that the *rate of development* of scientific progress is rapidly advancing.

Yet there is one respect in which it might almost be said that we have made less progress than the ancients. In those early days each lamp appears to have been the subject of individual design. Even the humblest clay vessels were shaped and decorated with a view to their subsequent use. The ornamentation was sometimes intended to describe the purpose for which the lamps were intended, and was designed with special reference to the surroundings. In some cases historic incidents and legends were carved in bronze. In others the whole design of the lamp was made to symbolize the deity to which it was dedicated.

In the present day, when lamps are turned out by the hundreds and thousands in our factories, we are apt to lose sight entirely of the decorative and artistic elements. Our illuminants are incomparably more efficient as producers of light than those of past ages. But they are designed with little reference to artistic considerations and are not infrequently used in surroundings for which they are not æsthetically suited. It may also be observed that the lamp of to-day is a very much more complex device than that of the ancients. It comprises the actual light-producing element, the apparatus for screening and distributing the light, and the means of support. Therefore the scope for scientific and artistic design is correspondingly greater.

We have lately been so occupied in the business of producing cheap and efficient illuminants that their purely utilitarian advantages have received almost exclusive attention. There are on every side practical problems in

connexion with the lighting of schools, offices, factories, &c., which demand the greater part of our attention, and the question of satisfying the hygienic requirements of lighting in such cases is doubtless the more pressing. Nevertheless, distinct progress in the æsthetic side of lighting has recently been made and the demand for artistic skill is growing. We understand that the services of artists are being used to a much greater extent in connexion with fixture design. Yet there are also awaiting us great possibilities in connexion with the artistic use of light which have hardly been realized as yet. In dealing with such problems it is well to have a knowledge of the methods of illumination of the past ages.

The Centenary of the Gas Light and Coke Co.

It is just one hundred years since the Gas Light and Coke Company came into existence, being incorporated by Royal Charter on April 30th, 1812, and the centenary has been celebrated during the past month. It is most interesting to look back on its early beginnings. The Company originated at a meeting held at the Crown and Anchor in the Strand in 1807, when 20,000*l.* was subscribed for the purpose of lighting Pall Mall with the new illuminant. To-day the Gas Light and Coke Company has grown into a gigantic enterprise controlling 29,000,000*l.* of capital, serving an area of 125 square miles and producing over 25,000 million cubic feet of gas during the year.

It is natural that such a huge concern should exert a powerful influence on the lighting industry. The competition of electric lighting has only served to stimulate invention and to bring out the latent possibilities of gas lighting. Indeed, it has often been remarked that the best thing that could have happened for electric lighting was the invention of the incandescent mantle, and, it might be added, the introduction of the metallic filament lamp has been equally instrumental in stimulating the progress of lighting by gas. We have every reason to expect that such progress will continue, and we have never concealed our belief that there are abundant opportunities for the expansion of both industries.

To Mr. Corbet Woodall, the present Governor of the Company, and incidentally the President of the Institution of Gas Engineers for this year, much of the recent success of the Company has doubtless been due, and he has been ably served by many of his lieutenants. In the Lighting Department, much has been done under Mr. F. W. Goodenough, who is also known to our readers as the Chairman of Council of the Illuminating Engineering Society, and his staff. We are glad to say that during recent years the value of the Illuminating Engineering movement to the gas indust y has been fully recognized. We have often pointed out how valuable to any company interested in lighting, whether concerned with gas, electricity, or any other illuminant, the development of such a movement must be. To many of the younger members in the Gas Industry this line of work makes a special appeal, and Illuminating Engineering will doubtless take a prominent part in their education in the future.

It may be added that simultaneously with the rise of the Gas Light and Coke Co. there has taken place a revolution in the attitude of the supply company towards the consumer. In place of the "take it or leave it" methods of the past we have a vastly more conciliatory policy, namely, to use every means to attract the consumer and to aid him in making the best of the gas supplied. With this end in view the maintenance of burners and mantles by the company has been encouraged, and we have no doubt that advice in connexion with illumination will be carried even further eventually. LEON GASTER.

Review of Contents of this Issue.

THE opening article, by DR. W. VOEGE (pp. 375-9), describes some researches on **A Method of Comparing the Colour of Light** from various illuminants. This is based on ordinary photometry supplemented by the use of a series of coloured glasses, and is suggested as a simplification of the spectrophotometer. Dr. Voege also gives the results of a complete series of tests on various artificial illuminants, and points out that the method might also be applied to coloured surfaces.

Following this will be found an abstract of the section of the **Report of H.M. Chief Inspector of Factories,** dealing with illumination, a special feature being MR. D. R. WILSON'S report on the subject. This contains a very complete series of tests of daylight and artificial lighting in cotton- and linen-spinning works, printing works, &c. There is also a short summary of some inquiries into the views of manufacturers in the United States, a general concensus of opinion being expressed regarding the necessity for good illumination.

On p. 387 an article is commenced dealing with **Light from the Earliest Times.** The article is based mainly on a lecture on this subject delivered by MR. J. W. JOHNSTON, and some photographs of his interesting collection of old lamps are reproduced. Some of these date from many years B.C., coming from Egypt, Nigeria, and other distant countries. A description is also given of some primitive methods of illumination utilized until quite recently in the British Isles, such as rush-lights, "peermen," &c. Progress in the scientific design of old oil lamps was almost stationary for many centuries, but much may be learned to-day from the study of the methods of decoration employed.

Following this is a series of short articles. On p. 386 reference is made to the **Lighting by High-Pressure Gas at Victoria Station**. A photograph taken entirely by artificial light is reproduced, and the results of some measurements of the illumination on the platform are given. Another short note relates to a suggested device for the guidance of airships and aeroplanes, namely, the erection on buildings of very large direction signs visible from a distance. These are to be made of silvered glass spheres, so as to reflect the sun's rays, and, by reason of their brightness, attract attention from a considerable distance away. PROF. RICHTMYER gives some data for correcting the Hefner standard of light (p. 397). A brief account is also given (p. 394) of the lighting of the Gymnasium at the Regent Street Polytechnic which is accomplished by tungsten lamps and Holophane reflectors placed high up on the panelled ceiling.

The succeeding series of Short Notes on Illuminating Engineering contains a varied selection of articles. An interesting illustration shows the **Lighting of Printing Works** on a plan devised by MR. J. R. CRAVATH, attention being drawn to the surprising amount of light reflected from the floor. There are also short notes on the **Lighting by High-Pressure Gas on Brixton Hill,** the custom of presenting costly lamps as offerings in the Grotto of the Nativity, **Electric Light in a Hindu Temple,** &c.

At the end will be found the usual **Review of the Technical Press,** the **Trade Notes,** and **Publications Received.**

Lighting and Extinguishing Gas Lamps by Hertzian Waves.

HITHERTO the automatic control of street gas lamps from a distance has been accomplished almost invariably by one of two methods—*i.e.*, clockwork or pressure wave devices, and the latter have come into very general use during recent years.

According to a recent number of *The Journal of Gas Lighting*, however, a highly novel method is being experimented with by the Paris firm of MM. C. & G. Grimmeisen, which proposes the application of wireless waves. By this method, it is suggested, the signal may be sent out from the works and the lamps ignited or extinguished at any instant with the same precision and ease as electric lamps. The mechanism is stated to involve three essential processes: (1) Turning on the gas at the main, (2) production of an electric spark or the incandescence of a suitable substance to ignite the gas, and (3) cutting off the gas from the burner.

The apparatus consists in (1) receiving antennæ for the waves transmitted from the central station, (2) a suitable wave-detector (magnetic, thermic, or thermo-electric), and (3) a relay operated by this wave-detector, whose function it is to produce the necessary currents for the above processes. The lantern would also have to be provided with a suitable source of electricity, such as a couple of dry cells. These should retain their charge for a long time, as they would only be in action for a few seconds daily.

This suggestion is a very interesting one, and, if practicable, would doubtless be of great benefit in street lighting. On the other hand, there are certain difficulties to be guarded against. For example, it is essential that the apparatus should work unaffected by changes in climatic conditions, atmospheric electricity, &c., and one must also take measures to prevent its being affected by wireless waves from other sources. It appears that this last requirement might be met by selecting a suitable system of tuning, so that the apparatus would only respond to a certain pre-determined range of frequency.

Lecture on the Prevention of Accidents.

WE note with interest that on July 4th last a lecture on 'The Prevention of Accidents in Large Factories' was delivered in Berlin by Dr. W. H. Tolman, Director of the American Museum of Public Safety in New York. It will be recalled that Dr. Tolman made an interesting suggestion at the recent Congress in Milan on the question of appointing a "safety engineer" for large factories to aid in preventing accidents. The above lecture, which was delivered in English and illustrated by lantern slides, was arranged by the A.E.G. Co. of Berlin for the benefit of their employees, and illustrates the growing recognition of the need for studying methods of preventing accidents in factories.

We understand that Dr. Tolman will be in England early in August. We can assure him of a welcome, and hope that an opportunity will be afforded for hearing him in this country.

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

The Determination of Colour in Artificial Illuminants.

BY DR. W. VOEGE (Hamburg).

AFTER reading the paper by Mr. T. E. Ritchie on 'Colour Discrimination by Artificial Light,'* it occurred to me that an account of a method devised by me for studying the colour of artificial illuminants would be of interest. This method enables the small differences in the colour of the light from two sources to be very easily determined and expressed.

The method employed by Mr. Ritchie was to illuminate a series of coloured materials by artificial light and daylight and to photograph them on a plate, the sensitiveness of which throughout the spectrum approached very closely to that of the human eye. Now, while this process may serve as a means of judging illumination, I venture to suggest that it is not well adapted as a means of testing the colour-effects of various sources, and for the following reasons :—

(1) The sensitiveness of a Wratten plate with K3 filter is appreciably less than that of the eye in the green, between $520\mu\mu$ and $560\mu\mu$, and, moreover, the relative sensitiveness to different colours is to some degree dependent on the time of exposure.

(2) It is at present difficult to define and reproduce a series of coloured samples with sufficient exactitude (*e.g.*, the terms used to define various tints are distinctly uncertain).

(3) Results obtained by the aid of photographic plates are only with difficulty presentable numerically and in graphical form.

* *Illum. Eng.*, Lond., Feb., 1912, p. 64.

For all these reasons it seems to be preferable to determine the spectrum composition of the lights and to draw conclusions therefrom as a result of actual experience with coloured materials and illuminated objects. Such spectrum analysis can be carried out with the spectro-photometer. But the method is ordinarily too complicated for practice, and presents great difficulties in the case of spectra which are broken up into individual lines. In this case a widely opened slit must be used, so as to secure a larger illuminated area. It is also somewhat questionable how far the results of different observers can be compared one with another.

The problem is considerably simplified if one works with coloured glasses, and selects them so as to separate out a series of adjacent regions in the spectrum, the intensity of which can be determined in the usual way. I published some researches based on this method in 1905,* but considerable progress has been made meanwhile, and the applications of such methods to so-called "daylight-lamps" are of interest.

Instead of placing a coloured glass in front of each lamp, I now use small monochromatic glasses about 20mm. in diameter, which are inserted in front of the eye-piece in the photometer so that the observer sees the image of the photometric field through them. Such glasses are made by Schott & Gen with a known transparency. By using these glasses alone,

* *Jour. f. Gasbeleuchtung und Wasserversorgung*, 1905, p. 513.

or in suitable combinations, the ranges in the spectrum shown in Fig. 1 can be secured. As it is not at present possible to produce a pure yellow glass, I utilize the glass No. 433 III., which, by transmitted light, appears yellow-green.

that the inverse square law would not apply.

It is better still to utilize a "Universal Photometer" of the type shown in Fig. 2, or a similar instrument. In the Schmidt & Haensch instrument the equality of brightness of the photo-

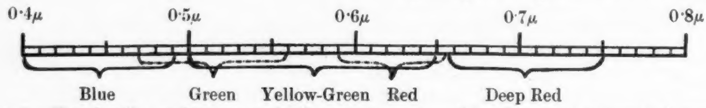


FIG. 1.—Showing the various ranges in the spectrum secured by the use of coloured glasses.

The colour-comparison between two lamps is now very easily accomplished by a simple photometric test, using successively the red, green, yellow, and blue glasses. We thus obtain certain relative figures, which are reduced to a common value in the yellow-green.

metric surfaces is adjusted by means of a rotating sector, both the sources of light meantime being stationary. In order to adapt the instrument for the colour measurements, the standard lamp at *O* (a small metallic filament lamp) is removed. Instead of it, a

TABLE I.

GIVING PARTICULARS OF COLOURED GLASS SCREENS USED.

Colour of Glass Used.	Material No.	Range of Spectrum Transmitted.	Wave Length of Max. Intensity.
Blue	447 III.	λ=0·40—0·47	λ=0·44
Green	431 III.	λ=0·47—0·56	λ=0·53
Yellow-green	433 III.	λ=0·5 —0·65	λ=0·56
Red	2745	λ=0·59—0·65	λ=0·64
Deep red	2745+450 III.	λ=0·66—0·75	λ=0·72

For the "comparison lamp" in these investigations it is desirable to select a lamp of high candle-power. All the colours should be well represented, and the intensity throughout the spectrum as uniformly distributed as possible. A Hefner lamp is not satisfactory for this purpose. Acetylene is preferable, but it is difficult to secure a sufficiently constant light, and a metallic filament or Nernst lamp of 50–100 H.K. gives the best result.

The measurements can be carried out on an ordinary photometric bench, but it is necessary to place the lamp tested at a convenient distance from the photometer, and only move the comparison lamp. When using these obscuring glasses, it is only in this way that one can get enough light. If one were to keep the lamps stationary, and move the photometer to and fro, it would often be necessary to bring the instrument so near to one of the lamps

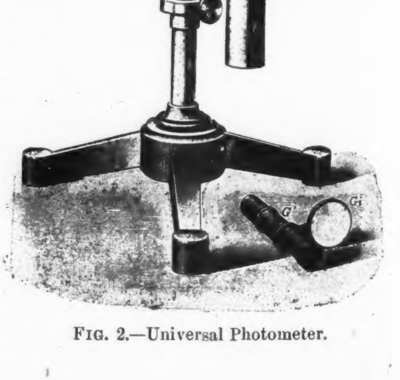


FIG. 2.—Universal Photometer.

Nernst lamp at a distance of 5–8cm. is substituted in front of the milky glass screen, the other screen being illuminated by the lamp to be tested. The adjustment of the light is carried out by means of the sector *S*, and the image of the photometric surface is observed through the aperture *A*, where the coloured glasses are placed, and the distance of the lamps from the instrument can be adjusted until the illumination, as seen through the particular glass employed, has a convenient intensity. The exactitude with which the measurements can be carried out is considerable, as is shown by the figures in Table II., representing the results of three series of observations comparing a Nernst and a 100 c.-p. carbon filament lamp.

(7) Arc lamp, ordinary carbons (8 amps.).

(8) Bremer arc lamp (8 amps.).

(9) "Carbone" arc lamp (10 amps.).

(10) Flame arc lamps :—

(*a*) with white-burning carbons (Siemens).

(*b*) with yellow-burning carbons (Siemens).

(*c*) with red-burning carbons (Siemens).

(11) Daylight lamp (Körting & Mathiesen, 8 amps.).

(12) Mercury vapour lamp (55 volts 3·5 amps.).

(13) Mercury vapour lamp (35 volts 3·5 amps.), with rhodamine reflector.

(14) Mercury vapour quartz tube lamp (220 volts).

TABLE II.

SHOWING AGREEMENT BETWEEN THREE SEPARATE EXPERIMENTS COMPARING NERNST AND CARBON FILAMENT LAMPS.

Colour.	Values Obtained.				Max. Deviation from Mean.
	(1)	(2)	(3)	Mean.	
Yellow-green	65·3	64·5	65·5	65·1	0·92%
Green	62·5	63·5	62·0	62·7	1·27%
Blue	49·6	52·5	51·0	51·0	2·94%
Red	72·4	71·0	72·0	71·8	0·83%
Deep red	76·5	77·0	73·5	75·7	1·72%

Even in the blue, where the light given by these lamps is exceedingly small, the average difference does not exceed 3 per cent. As an illustration of the sensitiveness of the method, it may be mentioned that the difference in colour in the light given by two petroleum lamps using distinct types of burners or different varieties of petroleum can be determined with confidence.

By this method (see Table III.) I have studied the following illuminants :—

(1) Daylight from a white, cloudy sky.

(2) Tantalum 110-volt 25 H.K. lamp.
Tungsten „ „ „

(3) Nernst lamp (80 H.K.)

(4) Petroleum lamp, "Reform" round burner (12 H.K.).

(5) Petroleum lamp, "Adonis" burner (28 H.K.).

(6) Acetylene lamp (30 H.K.).

The results of these tests are summarized in Table III., the values for daylight from the clouded sky being taken as unity. For the sake of comparison the values determined spectrophotometrically by Frl. E. Köttgen for the blue sky and direct sunlight are also included.

Taking, first, the illuminants which depend almost entirely on the incandescence of solid particles, one finds that the approximation to daylight is a matter of temperature. The higher the degree of incandescence the greater the accentuation of the green-blue end of the spectrum at the expense of the red. They can be arranged in the following order : Hefner, petroleum, carbon filament lamp, tantalum lamp, tungsten lamp, Nernst lamp, acetylene, arc light, sun.

The incandescent mantle is not to be considered as depending on pure

temperature radiation alone; while containing approximately the same amount of blue and green as the tungsten lamp, it yet contains considerably less red. A pronounced, discontinuous spectrum is yielded by the Bremer and the flame arc, and by the mercury vapour lamps.

The effect of the higher temperature of the quartz tube mercury lamp, as compared with the mercury lamp having a glass tube, is clearly distinguishable, and the action of the rhodamine reflector is quite striking, although, naturally, not unaccompanied by loss. For example, when a white reflector was used, the illumination at a certain distance was 240 lux, but this was diminished to 165 lux when a fluorescing reflector was substituted. This reduction of 30 per cent. is attributable mainly to the fact that the green rays have a higher luminous efficiency to the eye than the red. The loss of light is, however, counterbalanced by the improvement in the colour of the light.

It is interesting to observe from these figures how widely the individual sources of light differ from daylight. Daylight lamps give, on the whole, a good agreement with daylight (which is itself subject to considerable fluctuations, according to climatic conditions). In such lamps an enclosed arc is screened with suitable absorption glasses. The resultant light approached daylight very closely in the blue and green; but, in contrast to most artificial illuminants, there is a deficiency of red. This deficiency might be made good by a combination with carbon filament lamps. The resemblance of flame arc with white carbons is remarkably close, but, owing to the fumes given out by carbons of this kind, it is not considered desirable to use them in small interiors.

It may be noted that, although the colour of the mercury vapour lamp is substantially improved by the addition of the rhodamine reflector, there are still rays in the extreme red which are altogether lacking.

Table IV. illustrates the effect on the colour of the light of frosted and opal glass globes.

TABLE III.—CONTAINING COMPARISON OF COLOURS OF VARIOUS ARTIFICIAL ILLUMINANTS.

	Daylight.			Electric Glowlamp.				Petroleum.					Electric Arclight.						Mercury Vapour Lamp.		
Colour.	Cloudy Sky.	Blue Sky.	Sunlight.	Carbon Filament Lamp.	Tantalum Lamp.	Tungsten Lamp.	Nernst Lamp.	"Reform" Burner.	"Adonis" Burner.	Acetylene.	Incandescent Gaslight.	Hefner Lamp.	Ordinary Carbons	Bremer Lamp.	Yellow Flame Carbons	Red Flame Carbons	White Flame Carbons	"Daylight" Enclosed Lamp.	Ordinary Lamp with Glass Tube.	Ordinary Lamp with Rhodamine Reflector.	Mercury Quartz Lamp.
Blue	1·00	1·65	0·65	0·20	0·21	0·23	0·24	0·12	0·15	0·27	0·23	0·09	0·73	0·07	0·24	0·45	1·05	1·18	0·77	0·97	0·58
Green	1·00	1·33	0·85	0·79	0·79	0·88	0·84	0·74	0·79	0·84	0·89	0·73	0·97	0·67	0·75	0·90	1·21	1·18	0·88	0·80	0·78
Yellow-Green	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00
Red	1·00	0·77	0·90	1·76	1·63	1·63	1·58	2·18	2·12	1·37	1·20	2·24	1·35	1·90	1·16	1·68	0·97	0·40	0†	0·62	0·04
Deep Red	1·00	0·65	0·80	2·70	2·14	2·10	2·14	3·87	3·26	— *	1·13	3·9	1·70	0·87	— *	— *	— *	0·54	0†	0†	0†

* Measurement omitted. † Too small to measure.

The method described, which has shown itself very serviceable in examining and comparing the colour of the light from different illuminants, can also be applied to coloured materials. In comparing such samples, they are successively illuminated by the same lamp, and the reflected light from them passes on to the photometer screen. For example, in my researches I found it convenient to illuminate the coloured materials by a powerful projection Nernst lamp, while a 60 H.K. Nernst lamp serves as the comparison unit. The photometric comparison was then carried out through the coloured glasses in the usual way.

The absolute magnitude of these values is naturally dependent on the intensity of the lamp used. But we are only concerned with the relation of the figures to one another, which can be easily presented by reducing all the figures, taking one colour (*e.g.*, the yellow-green) as unity. The table enables us to see what kinds of light are most strongly reflected by the different materials. It will be observed that in general coloured fabrics reflect some light from most parts of the spectrum; for example, a sample which appears yellow to the eye also contains a very considerable proportion of green, red, and even blue light. By using different illuminants different results would, of course, be obtained. Investigations into the effect of coloured materials defined in this way, by means of the method adopted by Mr. Ritchie, would doubtless yield most interesting results.

TABLE IV.

EFFECT OF FROSTED AND OPAL GLOBES ON COLOUR OF LIGHT.

Colour.	Electric Glow Lamp.		Nernst Lamp.	
	Clear Glass.	Frosted Glass.	Without Globe.	With Opal Globe.
Blue	1·00	0·77	1·00	0·84
Green	1·00	0·97	1·00	0·89
Yellow-green...	1·00	1·00	1·00	1·00
Red	1·00	1·24	1·00	0·95

TABLE V.

TESTS ON COLOURED MATERIALS.

Colour.	Coloured Paper Tested.					
	Violet.	Blue.	Green.	Yellow.	Bright red.	Deep red.
Blue	69	61	15	15	5	1·8
Green	18	8	22	70	20	2·0
Yellow-green	28	4·5	14	81	22	6·2
Red	64	4·8	3·5	83	75	46·5
Deep red	74·5	13	20	83·5	83	68

Illumination in Factories and Workshops.

Notes on the Annual Report of H.M. Chief Inspector of Factories and Workshops for the year 1911

As announced in our last number, the Report of H.M. Chief Inspector of Factories has now appeared, and frequent reference is made to the subject of illumination. The introductory General Report contains several interesting items. It is stated, for example, that a museum of safety appliances is shortly to be erected. A site in Westminster has been secured, plans have been prepared, and the building will be begun as soon as possible. Valuable information with regard to the construction and administration of foreign institutions of the kind has been obtained by visits to those at Berlin, Vienna, Milan, Munich, and Amsterdam, and the number of such museums abroad is increasing. The general opinion is expressed that they have proved very valuable as a means of promoting the study of industrial hygiene.

Careful note was taken of the important sections of the International Exhibition of Hygiene at Dresden which were concerned with manual industries, and especially of the exhibits connected with industrial diseases and their prevention. Among these were records of research work on fatigue and illumination, directions in which further investigation is needed with regard to the industries of this country. On the latter point Mr. D. R. Wilson has made further valuable preliminary inquiries, some of the results of which are embodied in his report. The subject is wide and technical, and it is intended to refer it to a Committee of an expert character for further elucidation.

On p. 382 we give an abbreviated account of Mr. D. R. Wilson's excellent report. The precedent set by the inclusion of a special report no less than thirty-eight pages in length on the subject of illumination is a most important one, and shows the great value which is now attached to good lighting.

In addition, there are other references to illumination in the reports of the divisional inspectors. It is interesting to notice that the inquiries in this direction have been guided by the report of the recent Departmental Committee on Accidents. For example, Mr. Wilson, of Glasgow, remarks: "In consequence of the statements made before the Accidents Committee a large amount of attention was paid to the lighting of iron foundries. In the majority of cases this, both natural and artificial, was found to be good, and very few cases could be classed as poor. Mr. Crampton says that in most of those in which the natural light was bad the premises were old, and alterations for the better not easy to effect. Good light is essential to the production of good work, and Mr. Crampton refers to the problem of lighting as being ever present to occupiers, managers, and foremen."

Visits to a considerable number of foundries were therefore undertaken, and an attempt was made to classify them according to the nature of the lighting. Thus Mr. White found that of 46 factories visited, the lighting of 21 was good, 15 fair, and 10 poor. Mr. Rogers, however, found 213 factories to be well lighted, 241 moderately so, and 15 bad.

Preliminary steps have been made to ascertain how far bad illumination in foundries is responsible for accidents. It is pointed out, however, that the inquiry is complicated by a number of circumstances. For example, investigation showed in one instance that the number of accidents during the winter months was not much greater than during the summer; but it was pointed out that there are special

causes, notably the increase of temperature, which tend to increase the number of accidents in the summer quite irrespective of the illumination. Again, one inspector finds that out of the four works in which the number of accidents was highest three had imperfect lighting; but he had seen other, worse-lighted premises which were, nevertheless, comparatively free from accidents. But here, again, it would probably be found that the firms which had the best lighting also carried out their work most rapidly. A poorly lighted and inferior works might have few accidents merely because its output was small and the work carried out in a very slow and leisurely way. In the same way it has been found that during the winter months work proceeds, on the whole, less rapidly than in the summer, and this, again, tends to keep the number of accidents low. It is evident, therefore, that we must have additional data before very definite conclusions on this point can be formed.

Most of the inspectors agree that artificial lighting is steadily improving. Oil lamps and flat-flame gasburners are being steadily replaced by more efficient illuminants. Incandescent mantles, and particularly high-pressure gas lighting, are being more extensively used. In this connexion Mr. White (South-Western Division) remarks: "Those occupiers who have not tried them object that incandescent mantles would quickly become clogged with dust, but two up-to-date foundries have been visited where they are now in use, and little or no inconvenience is experienced from this, although, of course, the mantles sometimes get broken. One foundry which was using oil lamps at the beginning of this inquiry has now installed an acetylene plant, and the improvement is naturally very marked. Another (larger) firm of iron-founders has discarded coal gas for acetylene, and the place is now well lighted."

In the modern factories which are now being built the conditions of daylight are also very much better.

Frequent reference is made to the difficulties introduced by the dark surroundings met with in foundries, and stress is laid on the value of frequent limewashing. Another difficulty is the presence of moving machinery, such as travelling cranes, which are apt to throw inconvenient shadows.

On the question of colour the general view favoured white light. Mr. White remarks: "There can be no question as to which is the better colour, for when a white light is used, the eye can accommodate itself to the glare of the metal more easily than when the reddish-yellow one is employed; and, furthermore, the metal does not cast the deep shadows it does when light of the latter colour is in use, and, of course, a white illuminant is more powerful than a reddish-yellow one."

On the other hand, another inspector suggested that the blueish-white light of arc lamps is defective in penetration, and that presumably light of more or less ruddy character would be preferable. Reference is again made to the dangers attending the use of naphtha lamps.

Mr. Crabtree, speaking of cardrooms and weaving sheds in the cotton industry, alludes to defective illumination in rooms where "it is customary to place the lights, by hard and fast rules, at so many feet apart without reference to the machinery." Cases are mentioned of one light being used for four looms (which was insufficient), inadequately lighted passages and staircases, &c. In some instances artificial light is not switched on early enough in winter. It is interesting to note that, according to his experience, employers were disposed to consider favourably any suggestions for the improvement of their lighting, thus bearing out the remarks of Mr. Crampton.

Evidence of improvement in lighting is seen in the following:—"Lighting and its principles, apart from problems of ventilation and heating, and apart from questions of safety for life or limb under s. 18, is not a condition of health that can be directly controlled by the Factory Department, except in trades or processes certified as dangerous or injurious. Not a large number of definite complaints were received

by the branch—eleven in all in 1911—but verbal, informal complaints are often made to inspectors during their inspections. Although striking examples are reported of bad or defective conditions of light, both natural and artificial—including (*a*) simple insufficiency of daylight, due to bad structure or position of windows unnecessarily obscured by dirt, (*b*) insufficient or defective illuminants—satisfactory and cheering examples are also given of specially improved methods of lighting."

Further evidence to this effect is given by Miss Squire: "The general lighting, both by natural and artificial means, of the newer textile mills shows a striking advance on the old ones. Good means of diffusing light over the whole of the large spinning and card rooms are to be seen, especially in the mills spinning fine counts, where light and cleanliness are necessary for satisfactory production. A wonderfully good effect has been recently obtained in one of the older mills, where the structural defects prevented equal diffusion of light over the whole huge area, by covering the entire top of the room with sheets of metal and enamelling the whole white. The cost has been enormous, but the firm have considered it worth while."

An interesting account of a method of lighting in waterproof factories is given by Miss Pearson: "The electrician at a large waterproof factory has installed a new method of lighting in the departments in which the garments are machined. A small electric light bulb is fixed to the head of the machine just above the needle attachment; this bulb is blackened on the upper side, so that the light only falls on the needle itself and on the part of the material through which it is to pass, leaving the operator's eyes in the shadow. There is a separate switch for each light, under the control of the worker. The method appears to give satisfaction, as I found every light in use at the time of my visit."

These are the chief points dealt with in the General Report. We will now proceed to give an abstract of Mr. D. R. Wilson's special report.

SPECIAL REPORT ON FACTORY LIGHTING.

(In dealing with this report we are obliged to abbreviate many portions, and those desiring fuller details are referred to the official version; special interest attaches to the complete series of measurements of illumination tabulated in the Appendix.)

Introduction.

Illumination may be regarded from two points of view—"general" and "local." The term "local" is applied to the lighting of a small, circumscribed area, on which specific work is being carried on, and "general" to the lighting of the workshop as a whole. The two systems of lighting are, however, often not sharply distinguishable.

A distinction must also be drawn between daylight and artificial illumination. Whereas artificial illumination is fairly constant, daylight varies from hour to hour and from day to day. These variations are not always evident to the eye, but they necessitate special methods of testing. Two rooms may appear to the eye to be lighted equally well by full daylight; but, when the light begins to fade, a difference in their qualities becomes more and more apparent. A further distinction is, that in artificial illumination we are able to control the position of the light-sources, whereas in the case of daylight this is not so.

Daylight Illumination.—For the efficient daylight illumination of a given room: (1) The amount of daylight admitted should be as large as possible; (2) the lighting should be as uniform as possible; (3) the light should fall on the work from the right direction. In order to satisfy (1) two conditions should be observed: (*a*) the window area, relatively to the floor, should be at least 1 : 10, and (*b*) the windows should be as free from obstruction (*i.e.*, should command as large an extent of sky-area) as possible, in order to allow the admission of direct, as opposed to reflected, daylight. As will be seen later, the first condition (*a*) is particularly well observed in weaving sheds

and similar buildings, in which the windows are commonly placed in the roof. In large rooms lighted by side-windows, however, it is often impossible of fulfilment. The second condition (*b*) is also fully observed in rooms lighted from skylights, but is obviously difficult of attainment when side-windows are used and the factory is surrounded by adjacent buildings.

Other important matters are the variety of glass used (whether clear, frosted, or ribbed) and the absence of dirt and soot, the symmetrical placing of the windows, and the nature of the walls. Walls that are light in tint and have a matt surface greatly aid the diffusion of light. In a small room the illumination may sometimes be increased as much as five times by this means.

Assuming that the above points have received attention, it is also desirable that the light entering the room should reach the centre or darkest point with as little obstruction as possible, and that dark shadows caused by local obstruction of the light should be avoided. The completeness with which this can be done depends on the shape and height of the machinery; in a room full of tall cotton-spinning machinery the obstruction is necessarily great. For side-lighted rooms the best position for machines is an arrangement in rows across the room, with the ends of the machines opposite to the wall-spaces between the windows. In this way the light is allowed full access to the gangways and the surface of the machines. Composing frames should be arranged in a similar way.

In rooms containing only small machines the arrangement is from this standpoint less important, but a side-light is usually desirable for other reasons—*e.g.*, distribution of shadow. For the avoidance of shadow light coming from the roof is the best, since the shadow is then formed immediately under the plane of work, where it is of no importance ; in side-lit rooms the light should fall on the work from the side in such a way that no shadow from the operator's body is thrown on the work. A moving shadow is more troublesome than a stationary one. In general such shadows are most apt to be produced by artificial light.

Artificial Light.—In planning artificial lighting attention should be given to the following principles : (1) The light should be adequate having regard to the nature of the work carried on ; (2) the light units should be arranged so as to cause no "glare" effects ; (3) the light units should be arranged so as to produce no troublesome shadows.

The intensity of illumination needed depends on the nature of the work, fineness and colour of material, and other circumstances, and should vary according to the reflecting power of the material on which the work is being done. When materials of various tints are used, it is often desirable to have some means of varying the illumination by adjusting the distance away of the light-source.

Glare may be defined as the dazzling effect of a powerful light. The causes and effects have been fully discussed in *The Illuminating Engineer*, and Prof. L. Weber, of Kiel, has suggested a series of rules.*

From this it would seem that the most important points to be taken into consideration are (1) the position of the light, and (2) its efficient shading. The light should be placed so that the angle between the direction of normal vision and the line from the light-source to the eye (termed "the angle of glare") should not exceed thirty degrees ; or, if the light comes within this angle, it should be provided either with an opaque shade so arranged as to render the light source invisible, or with a diffusing shade reducing its intrinsic brilliancy to less than 2·5 c.-p. per square inch. In most instances glare can be avoided by raising the lamps sufficiently, and it is desirable to keep powerful lamps high up. In shading lamps special care should be taken to ensure that its depth is sufficient to screen the lamp completely from the eyes. Shades are also of considerable service in concentrating the light on the work. For example, cases are mentioned in which the illu-

* *Illum. Eng.*, vol. iii., 1910, p. 116.

mination from bare lamps on a surface 2 ft. 3 in. below them was increased respectively from 1·2 to 3·1 and from 2·5 to 7 foot-candles by the use of prismatic glass reflectors. The shade should also be selected with regard to the natural distribution of light from the illuminant with which it is to be used, so as to direct the light in desirable directions.

An effect sometimes spoken of as glare is produced by light directly reflected into the eyes of the operator from highly polished surfaces, such as are met with in engraving on copper. The remedy consists in careful selection of the position of the light source and effective shading, with a view to making the light as diffused as possible.

Reference has been made above to the question of shadow. The unit serving each area should be placed so that its light comes from the side—or, better—over the shoulder of the worker or from directly behind him. A common failing is for light to be so placed that the worker's own shadow is cast on the work; this causes much annoyance, as it is continually shifting with his movements, and can be avoided generally by better shading and raising the lamp. The fault is very common in composing-rooms, where the workers stand and the lights are comparatively low.

As regards the colour of illuminants, the matter is relatively unimportant as far as work is concerned, for most industries, provided the illumination is adequate. There are, however, certain questions regarding the physiological effect of colours and of the ultra-violet and infra-red rays, but on these scientific opinion appears to be still divided.

Method of Determination of Illumination.

The observations were made with a Holophane lumeter (a form of illumination photometer which has the advantage of being extremely portable), furnished with certain accessories giving an increased range of 0·01 to 1,000 foot-candles, and allowing the determination of "window-efficiency."

Generally speaking, measurements were made in a horizontal plane 3 to 4 ft. from the ground, but in special circumstances measurements were taken on vertical or inclined planes. For example, in the case of compositors' frames determinations took place on the slanting upper case of each frame. In local lighting measurements were made in the plane of the actual work

The total number of measurements was 2,500. No attempt was made to secure very great accuracy, as it was thought advisable to collect data for as many rooms as possible, so as to obtain a general view of the conditions of lighting in each industry. Results are expressed in foot-candles. To give an idea of the strength of an illumination of 1 foot-candle, it may be mentioned that this is, roughly, the minimum value which enables small print to be read, that 0·1 foot-candle is about the minimum illumination in a well-lighted street, and 0·01 the minimum value in a badly lighted street

In measuring the daylight-efficiency of windows the method originally devised by Mr. A. P. Trotter, and more recently utilized by Mr. P. J. Waldram, in which the illumination in the room is expressed in thousandths of the unrestricted daylight illumination out of doors, was employed. It is pointed out that daylight measurements of this kind are necessarily very approximate.

(*To be continued.*)

Views of Manufacturers on the Lighting of Factories and Workshops.

A gratifying recognition of the importance of good lighting in factories and workshops was recently afforded by the action of the National Association of Manufacturers in the United States, who appointed a committee to consider the questions of ventilation, heating, and lighting. This Committee

reported at the annual meeting of the Association held in New York in May, 1911.

During the year inquiries on the subject of the effect of conditions of illumination on business were sent out to a large number of firms, and replies received in 250 cases. We have before us a copy of the report issued on this subject, which quotes some typical replies received. For example, a shoe factory reports that the painting of walls and ceilings a light colour has led to better results and more satisfied employees, and a jeweller comments upon the increasing demand for good light in modern work. A manufacturer of caramels states that proper lighting is absolutely necessary in order to get the best results and to increase the production, and a motor-car company replies to the same effect.

One very interesting reply was to the effect that although the artificial lighting was very good, nevertheless the output under daylight was 20 per cent better than when artificial illumination was used.

In short, it would appear from this report that a large number of firms having very widely different business are in agreement as to the importance of good lighting conditions, and fully recognize its direct effect on quality and output of work. Nevertheless,the Committee concludes that there is much yet to be done to improve the prevailing standard of illumination. The following are their concluding remarks on the subject :—

In very many cases there is insufficient illumination. This condition, however, is rapidly improving as the result of the advent of lamps of various kinds of much higher efficiency than anything that has been available in the past. It is a fact, however, that in a great many cases where the absolute amount of illumination is sufficient, the light is nevertheless exceedingly unsatisfactory for various reasons. If the light falls on the work from the wrong direction, not only is there great liability that awkward shadows of the machinery or of the operative's body will interfere with the work, but in addition if light is reflected from polished portions of the machinery or from the work itself directly into the eyes of the operative, the results will be anything but satisfactory. Failure of light to come in the right direction is often very distressing to the eyesight, and also, in addition, since it may cause the operative to work in an unnatural position, it may result in unnecessary bodily fatigue as well. Such unfortunate results are often obtained if an attempt is made to light a workroom with too few sources of light. Under these conditions, although some operatives may receive a very satisfactory light, others are extremely likely to get the light in the wrong direction, with the unsatisfactory results above enumerated.

Another very common defect in factory lighting is the exposure of the eyes of the workers to the direct beams of very brilliant lamps. The use of bare incandescent lamps is almost invariably not only inefficient, but also dangerous.

Still another defect often seen is either too great or too little contrast in the illumination of rooms. The former of these is by far the most common, and as an example might be given work on sewing machines, where individual lamps with opaque reflectors are supplied which brilliantly illuminate the machines, but leave the rest of the room in comparative darkness. This too great contrast is a great strain on the eyes. On the other hand, the brilliantly lighted room in which the illumination of all surfaces is practically equal to that of the working surfaces is also bad, since the eyes thereby are given no opportunity for rest when raised momentarily from the work.

A great waste of light is often permitted to occur, owing to the failure to keep lamps and equipment clean. The loss of light due to this cause is often as great as 50 per cent One reply from a typewriter company, stated that their incandescent lamps were cleaned and polished once a week.

In conclusion, the Committee believes that the subject of artificial illumination is one of great importance and well worth careful investigation.

High-Pressure Gas Lighting at Victoria Station.

By an Engineering Correspondent.

The accompanying photograph was taken by Mr. V. H. Mackinney during the investigations on railway lighting described at a meeting of the Illuminating Engineering Society in December last.

The photograph was taken under considerable difficulties. The platform was occupied by piles of luggage and crowds of moving people, which naturally tends to give the floor a somewhat dark and blurred appearance. (It is curious to notice that among all the distributed luggage one single bag apparently remained untouched during the exposure, and has, therefore, appeared in the photograph.) The difficulty of securing the correct exposure was accentuated by the fact of the surroundings being so dark in comparison with the lights. Measurements with the Holophane Lumeter showed that the surface-brightness of the roof girders was only about 0·05 foot-candle; the clock, on the other hand, was about 5 foot-candles; while the lamps themselves may be regarded, for photographic purposes, as over 1,000.

Some reference to the conditions of illumination in the station was made at the meeting of the Illuminating Engineering Society by Mr. J. G. Clark. Inverted high-pressure lamps (56 in.) are now employed. It is interesting to note that, when the change was made from upright to inverted burners some years ago, it was found that a saving of 40–50 per cent of gas had been made, while the illumination was maintained at practically the same figure as before. At the present time the minimum illumination on the platforms thus lighted is about 0·2–0·25 foot-candle, thus agreeing very well with the desirable minimum suggested by Mr. Haydn T. Harrison for well-lighted main stations.

Light from the Earliest Times.

An account of some lamps in the collection of Mr. J. W. Johnston (Fellow of the Society of Antiquaries of Scotland), and of a lecture recently delivered by him on this subject.

It will be recalled that some months ago reference was made in *The Illuminating Engineer* to a most interesting lecture on ancient forms of lamps and illuminating apparatus delivered at Hendon by Mr. J. W. Johnston.* By the great kindness of Mr. Johnston we have been favoured with a copy of the manuscript of this lecture, and were also given an opportunity of inspecting and taking photographs of his unique collection of old lamps. In this article we shall describe some of these interesting relics, the information being based mainly on Mr. Johnston's lecture, supplemented by extracts from some works on these subjects which he has kindly placed at our disposal.

The study of these old relics is of engrossing interest. To the antiquary and the historical student it is a duty to preserve, while we may, the fast-disappearing traces of past ages. Few things are more remarkable than the rapidity with which old articles are replaced by sweeping modern innovations. Many old forms of oil lamps, for example, such as were in common use everywhere in the British Isles before the introduction of paraffin and petroleum, have disappeared so completely that there are only a few specimens, in various museums and private collections, still in existence.

But these ancient methods of illumination have for us a certain technical interest. The expert lighting engineer can learn much by studying the historical development of methods of illumination and their influence on social conditions. In dealing with problems in illumination where artistic considerations are of importance such knowledge would stand him in good stead. And the ornamental design of many old forms of oil lamps and candlesticks, &c., would often furnish some valuable hints to the fixture-designer of to-day.

There can be no question that light has played a great part in moulding methods of thought and religious observances. It formed an integral portion of the observances and ritual of the very oldest sects, and Dr. M. Gaster* has shown how the worship of old Babylonian, Egyptian, and even later beliefs can be traced ultimately to the worship of the heavenly bodies. The very names of the heathen deities are those of the sun, the moon, and the planets (*e.g.*, Ra, "the Sun," one of the chief gods of Egypt, and Jupiter, Neptune, Mars, &c., in Roman mythology).

Many superstitions are also connected with light and the observance of natural phenomena. "Jack o' Lantern," or "Will o' the Wisp"—the faint flame sometimes seen floating above marshy grounds—was supposed to lure travellers to their destruction. The light of the glow-worm and the firefly have also been attributed to supernatural origin, and in the most remote antiquity there were "sacred fires" consisting of ignited natural gas and inflammable vapours issuing from the earth.

It is very uncertain when man first learnt the art of producing fire. The fable attributes to Prometheus the stealing of the art from heaven. Virgil and Pliny, both of the first century, mention the production of fire by striking stones together and by friction with pieces of wood.

At a much later date both these methods were shown to be in common use among many savage races. Capt. Cook in 1770 witnessed and described the use of fire-sticks by the natives

* *Illum. Eng.*, Lond., May, 1912, p. 228.

* *Illum. Eng.*, Lond., vol. ii. 1909, pp. 371, 462, 520, 586, 660, 731 804.

in eastern Australia, the process only occupying about two minutes. Similar methods are practised by people in many remote lands—in Greenland, Brazil, and probably in many other countries.

A later development of this principle was the tinder-box, in which a spark was produced by the rubbing or striking of a flint with steel (an old file being often used for the purpose). The spark was caused to ignite some inflammable tinder, originally a piece of well-scorched linen being used, and later brown paper soaked in a solution of saltpetre and dried. The material, however, varied in different countries. It is most interesting to see how wide-spread the use of such devices became. Not only was the tinder-box known in Europe, but it was in common use in China, Japan, Thibet, and other Eastern countries, and some very elaborate and costly specimens have been preserved. Several examples of these appliances are to be seen in Fig. 2, including an early French variety coming from Canada, a horn tinder-box from Jamaica, and a pocket flint and steel from Aberdeenshire.

The evolution of matches was a very gradual process. An ingenious early contrivance consisted in the enclosure of a piece of phosphorus within a tube. The phosphorus could be brought to ignition by merely driving in a piston and compressing the air.

It was not until 1833 that phosphorus matches were made a success. Sulphur matches were used in conjunction with tinder-boxes, being ignited from the burning tinder. Another form of match, the "Promethean," was invented in 1828. This involved a glass tube containing sulphuric acid placed within a mixture of chlorate of potash and sugar. To produce a light the end of the tube was broken off by a pair of nippers (supplied with the box), and the acid being liberated set fire to the potash and sugar, and so to the roll of paper attached. The lucifer or friction matches were first produced by John Walker, a chemist of Stockton-on-Tees, in 1827, a box of fifty being sold for half a crown, but the safety matches of to-day were not invented until 1855.

That the principle of the tinder-box is still not without value is shown by the recent Continental introduction of a device utilizing the sparks produced by rubbing the mineral cerite to ignite petrol-vapour. The device is really nothing but a more perfect and scientific form of tinder-box. It furnishes an interesting example of the improvement of discarded inventions of the past. Another testimony to its convenience is provided by the tinder-box served out to British soldiers during the South African War, and invented by Edward Lovett of Croydon. This contained, as well as flint, steel, and tinder, a glass for concentrating the rays of the sun. Focussing the rays of the sun by a burning-glass, in order to ignite inflammable substances, is of ancient origin, and appears to be not without merits in countries in which strong and continuous sunlight is nearly always available.

Let us now pass on from methods of ignition to illuminants.

Some vessels believed to have been used as lamps by prehistoric men have been found in the British Isles. For example, Mr. J. Romilly Allen mentions the stone lamps of the Iron Age that have been unearthed in this country, and also the recovery of chalk cups, which apparently acted as receptacles for inflammable material, from the ancient flint mines of Brandon, Suffolk.*

But it is to the East that we must go for the most complete records of antiquity. The ancient Egyptians, Greeks, Romans, and Hebrews all devised more or less elaborate methods of illumination, and in Mr. Johnston's collection there are several hundreds of such lamps, some of them dating from many years B.C. Such lamps were frequently made of clay or terra-cotta in place of the stone appliances dating from prehistoric times. In Fig. 1 is shown quite a series of such lamps, numbered and classified by Mr. Johnston. No 17 is of the simple black

* 'The Archæology of Lighting Appliances,' *Proceedings* of the Society of Antiquaries of Scotland, vol. xxii. p. 79.

stone prehistoric variety. Others, coming from Karnak, Thebes, and Beni Hassan, are of pottery, in some cases with a coloured glaze. In all cases the method appears to have been merely to produce a simple vessel to contain fat or oil, such as could be conveniently carried in the hand and would rest securely on a flat bottom when set down. The simplest forms only utilize most interesting to observe how, for hundreds of years, the essential points in the design of these lamps remained the same, and to contrast this rate of progress with that of the last ten years —that have seen the development of the metal filament lamp, the flame arc, the high-pressure gas lamps, and other entirely new forms of illumination!

But our records do not stop short

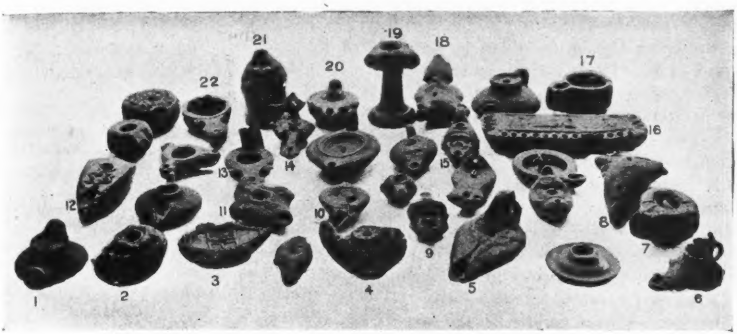


FIG. 1.—Group of Egyptian Pottery and Bronze Lamps. (36 Specimens.)

(1) Red Clay Lamp, with original wick, Thebes.
(2) Coptic Lamp, ornamented with Frog, Karnak.
(3) Terra Cotta Lamp, 5 wicks, Thebes.
(4) Prehistoric Red Clay Lamp, ornamented with concentric circles, pottery with similar circles dated back 4,777 B.C., Thebes.
(5) Red Long-Shaped Clay Lamp ornamented, Thebes.
(6) Bronze Lamp, Beni Hassan, Minieh, Upper Egypt.
(7) Greek Lamp, with lug on left, Karnak.
(8) Clay Lamp, peculiar shape, with lug underneath, Thebes.
(9) Clay Lamp resembling the face of god Bess, Karnak.
(10) Greco-Egyptian Lamp, ornamented with the head of Serapis.
(11) Clay Lamp, richly ornamented, Thebes.
(12) Lamp carved out of stone, Thebes.
(13) Bronze Lamp, Karnak.
(14) Bronze Lamp, fine work, Karnak.
(15) Clay Lamp, ornamented with face, Arabic imitation of Roman, Luxor.
(16) Terra Cotta Lamp, 20 wicks, Beni Hassan, Minieh, Upper Egypt.
(17) Black Stone Lamp, prehistoric, Karnak.
(18) Dark Red Clay Lamp, 2 wicks, Karnak.
(19) Terra Cotta Standard Lamp, 3 wicks, Karnak.
(20) Blue Green Glaze Roman Pottery Lamp, Karnak.
(21) Clay Incense Burner, Beni Hassan, Minieh, Upper Egypt.
(22) Bronze Lamp (unfinished), no hole for wick, Beni Hassan, Minieh, Upper Egypt.

a single wick, but others are more complicated, and it will be seen that No. 16, from Beni Hassan, has as many as twenty.

From a utilitarian standpoint the lamps are exceedingly primitive, and the light they gave, with the available fats or crude oils of that day, must have been exceedingly feeble. Many of these lamps date from several hundred years before Christ. It is of a few hundred years B.C. The most remarkable lamp historically—shown in Fig. 1—is No. 4. This is believed to go back to no less than 4777 B.C., the date of Mena, the first king of Egypt, and is proved to have existed before this time by the curious concentric circles marked upon the vessel, which are characteristic of the decorations of this early period. Yet even this lamp really presents little difference

in design or efficiency from those in use even down to the fifth century A.D.

But if these early lamps show little sign of inventive ability as compared with modern illuminants, they are interesting for their æsthetic design and decoration. In many cases these early lamps have been very carefully shaped, both with a view to utility and appearance. For example, the form is such as to give maximum stability, and when no handle is provided, ingenious slots and excrescences are made on the surface so as to give a good grip. In addition to this, both the Egyptian and the later Etruscan clay lamps are often exceedingly well proportioned, and much thought has evidently been given to their embellishment. The same applies to pedestals designed to carry these lamps. Lamps often show quite distinct features, according to the use for which they are intended (those used in the home, for example, differing in shape and design from those intended for use in the temple).

A somewhat curious circumstance mentioned by Mr. R. C. Clephan, F.S.A.,* is that practically no lamps have been found among the Egyptian tombs. Yet the elaborate decorations in the interior of these huge catacombs could hardly have been accomplished without the aid of some tolerably efficient form of artificial illumination.

In the lamps of somewhat later date more elaborate shapes and decorations came into vogue. From the study of the figures graven on the ancient Roman and Greek lamps much can be learnt In a most remarkable book, published in Paris in 1719, illustrations of a considerable number of such lamps are given.† In some cases very grotesque and fantastic shapes are adopted. For example, the handles are made in the shape of a swan's neck, or the lamps in the form of elephants, snails, and curious birds and beasts, often carved with a great deal of elaborate ingenuity. In some cases grotesque figures carry a wick issuing from an enormous mouth; or the wick is made to project from a vessel in the form of a sandal, &c. In some of the larger lamps complete historical incidents or legends, such as the Fall of Troy, are depicted.

Sometimes, too, the lamps are consecrated to certain deities—Serapis, Mercury, Jupiter, &c., and the whole design is worked out with a symbolic expression of the presumed characteristics of the god to which it is dedicated. A very common practice was also to make the lamp in the form of a cock:—

"The cock that is the trumpet to the morn
Doth with his lofty and shrill sounding throat
Awake the God of Day."

However, the cock seems to have become rather curiously associated with the Prince of Evil. Harold Bayley says: "In England, at any rate, the cock was regarded with disfavour by the Church, as a sort of devil's messenger from his crowing after Peter's denial. Throwing at cocks with a stick was a Shrove Tuesday pastime, which was enjoyed by many divines as a pious exercise." In the early Coptic lamps, and in lamps used in Christian churches, the cross was, of course, a common embellishment, and there were also representations of Scriptural events.

It would seem that one of the very earliest and obvious of all illuminants was the torch. This frequently consisted merely of a splinter of resinous and inflammable wood, pine being frequently used. Such torches gave a smoky and wavering light, but they were for long the recognized method of illumination. Sir Walter Scott, in 'The Legend of Montrose,' describes a banquet in the hall of the House of Menteith, when "behind every seat stood a gigantic Highlander ....holding in his right hand his drawn sword with the point turned downwards, and in the left a blazing torch made of bog-pine."

Forms of clips to hold the kindled splinter or rush-light were in common use in remote districts until quite recent times. It will be recalled that,

* 'Terra-cotta Lamps,' *Proceedings* of the Society of Antiquaries of Scotland, vol. v.

† L'Antiquité expliquée et représentée en figures, vol. MDCCXIX, by Dom Bernard de Montfauçon.

in referring to von Benesch's work on 'Illumination in the Middle Ages,' a view was given of an old smithy in Mühlviertel (Austria), in which such an adjustable clip was used.* In F g. 2 we see a selection of the apparatus of this kind in Mr. Johnston's collection, rush-clips from Ireland and Wales and "peermen" from Scotland being shown.

The material burned was usually either splinter of fir or rush-light. Such fir splints are termed "peermen,"

FIG. 2.—Group of Rushlights, "Peermen," Tinder Boxes and Stone Lamp. (14 Specimens.)

(1) Rushclip, Ireland.
(2) Rushclip, Wales.
(3) Rushclip, Ireland.
(4) "Peerman," Aberdeenshire, very primitive, being all wood.
(5) "Peerman," Banffshire.
(6) Primitive Stone Lamp, Aberdeenshire.
(7) Domestic Tinder Box, flint, steel, tinder, and damper.
(8) Tinder Box, Canada, early French period.
(9) Horn Tinder Box, Jamaica.
(10) Pocket Flint and Steel, Aberdeenshire.

or "puirmen" (poor men), in Scotland. The origin of the name arose from the fact that poor men, vagrants, or tramps ("gaberlunzies," as they were

* *Illum. Eng.*, Lond., vol. ii, 1909, pp. 525, 600.

called) cut the splinters and turned an honest penny by selling bundles about the country at a shilling each.

The rush-light dates back to very early days, but was in quite common use until about fifty years ago. Gilbert White, in his 'Natural History of

FIG. 3.—Group of Hanging Lamps. (6 Specimens.)
(1) Incense Lamp, pewter and copper, with brass bell, Italy, sixteenth century.
(2) Egyptian Mosque Lamp brass, inlaid with enamel.
(3) Church Lamp, brass, seven wicks.
(4) Egyptian Mosque Lamp, pierced brass, with coloured glass.
(5) Egyptian Mosque Lamp, brass, inlaid with silver.
(6) Egyptian Mosque Lamp, 3 lights, beautifully pierced brass.
The Egyptian Lamps are from Thebes, Karnak, and Cairo.

Selborne' (1775), describes their manufacture in some detail. It was quite a complicated process, the rushes being successively cut, allowed to rest in water, stripped of the peel, and laid out on the grass to bleach. When dry, they were dipped in scalding fat or grease, the careful housewife frequently using the residue from her bacon-pot for the purpose. In other cases coarse animal oils were used. A good rush about 2 ft. 4 in. long would burn for very nearly an hour, and it is estimated that a poor family could enjoy five and a half hours of light for about a farthing. Sometimes the burning rush was allowed to rest on the top of an old chest or other piece of furniture, and would go out automatically when the projecting portion had burned away. The edges of old

furniture are often found to be burned into shallow grooves through this practice. The rush-light was the forerunner to the wax and tallow candle, and was utilized in the poor man's home long after the wax candle had become the usual means of illumination for the rich. The candle has become associated with many popular sayings: "The game is not worth the candle," "Not fit to hold a candle to...." "He burns the candle at both ends," &c.

Before leaving torches and candles, a word or two should be said on the "link-boys," whose duty it was, within the memory of many people now living, to escort pedestrians home by torch-light on dark nights. A newspaper cutting dated May 14th, 1840, refers to "the last of the link-men," so that it must have been about that time that the profession ceased to exist.

Many of the old candlesticks and chandeliers were of most pleasing design. In the Middle Ages a chandelier containing an immense number of candles was a very usual form of gift for a rich man to make to the Church, and some of these enormous coronæ are to be seen in the cathedrals to this day. In some instances they have been converted to electric light, sometimes with rather incongruous results.

Oil lamps have also played a great part in religious worship, the finest varieties of oil being used. Here, again, the actual light yielded by the lamps was relatively insignificant, but the design was often exquisite. A series of lamps of this kind is shown in Fig. 3. The artistic effect of the brasswork will be noticed, the intricate pierced pattern on the Egyptian mosque lamps being particularly fine.

(To be continued.)

The Centenary of the Gas Light & Coke Company.

The Gas Light & Coke Company, which was incorporated by Royal Charter on April 30th, 1812, recently celebrated its centenary, and some account of its history has been issued in the form of an interesting and well-illustrated book.

The growth of this enormous undertaking is traced from its first beginning, when £20,000 was subscribed for the lighting of Pall Mall, up to the present time, when it serves an area of 125 square miles, and manufactures as much as 25,000 millions of cubic feet of gas in one year.

Several interesting historical facts are brought out—*e g.*, that the price of gas in the early days was 15*s.* per 1,000 cubic feet—just six times the price at the present time. Then the gradual absorption by the Company of many smaller undertakings is referred to, and it is pointed out that an important result of these amalgamations was the erection of the great Beckton gasworks, which allowed of several smaller establishments in central London being closed.

A very important step in the progress of the Company was taken when, after Mr. Corbet Woodall's appointment to the governorship, he established a sales department, with a view to gaining better relations with the public by giving good service, and also, by advertising and canvassing, to push the sales of gas. This policy has been very ably carried out by Mr. F. W. Goodenough, who was appointed controller of the new department, and whose name is familiar to readers of this journal as the Chairman of Council of the Illuminating Engineering Society.

The introduction of the system of co-partnership has given every employee of the Company a direct interest in its prosperity, and all the workers are encouraged by the provision of lectures and courses of instruction in the various branches of gas lighting, to qualify for higher positions in the service of their Company.

The Gas Light and Coke Company may well be congratulated on attaining its centenary with such a good augury for future prosperity.

The Lighting of the Gymnasium at the Polytechnic, Regent Street.

By an Engineering Correspondent.

The accompanying illustration shows the method of lighting adopted at the Regent Street Polytechnic Gymnasium. Tungsten lamps and Holophane reflectors are studded in the panels in the ceiling, the arrangement being designed with a view to concentrating a flood of light over the floor without producing any inconvenience from glare. The method of fixing the lights direct on the ceiling is very advantageous in this respect. A performer on the horizontal bar, seen in the background, for example, would be quite unconscious of the lights above, and a spectator from the gallery would not be able to see the lights at all. He would, in fact, be in the same advantageous position as the audience at the theatre, in seeing only the illuminated objects, and not the means by which this illumination is produced.

This is a point which might well be borne in mind in arranging the lighting of such displays. It is essential to produce a fairly strong light over the entire floor, so as to enable the performance to be seen with ease. But it is possibly even more important to screen bright sources of light from the eyes, or at least to keep them out of the direct range of view. Such defects might, perhaps, not be very noticeable during a casual visit, but make themselves distressingly evident to any one sitting in the room for some hours.

Fig. 1.—Lighting of the Gymnasium, the Polytechnic, Regent Street, London, W. (from the floor).
Photograph taken entirely by artificial light.

Novel Luminous Airship Signals.

By A Correspondent.

The rapid progress of aviation and aeronautics demands the development of a system of signals which will enable pilots to find their way in the air, and will also indicate convenient landing-places, atmospheric conditions, &c. Some of the most important events of the year are long cross-country flights. Racing in small closed circuits will gradually be abandoned. The establishment of regular lines of airship transit, as proposed by Count Zeppelin, and the success of aerial touring in general, also depend upon the invention of such a system of signals.

One proposed method involves the construction of special aeronautical charts; another requires merely the establishment of easily visible signals by which the pilot can find his position on the very accurate ordnance maps which are commonly used as standard maps in the principal European countries. In the French system the country is divided into 258 districts, each of which extends about 38 miles east and west and 24 miles north and south, and is represented by a numbered section of the map.

According to one proposed system of signals, a large rectangle having the proportions of the corresponding map section, and in the correct relative position to the points of the compass, will be marked out on the roof of a balloon shed or other building, or on the ground (and presumably lighted artificially during the night time). The rectangle is marked with the number of the section, and the exact position of the locality in the section is indicated by a conspicuous mark. A glance at any one of these signals near which he passes will show the pilot his exact place on the maps, so that he may not be long lost or far astray if the signals are sufficiently numerous. A predetermined course can be followed without carrying a set of maps. It is necessary only to draw, on a small card, a rough outline of the sections crossed by the course and the adjacents thereto, to mark each section with its proper number, to mark the positions of the starting and the destination points, and to connect these points with a straight line.

If the signals are composed of white lines on a black background, or conversely, they need not be very large in order to be visible at a considerable distance. A rectangle 12 ft. broad and 20 ft. long, with lines 20 in. wide and figures 6 ft. in height (in actual use at Mourmelon) is easily seen from a distance of 1 mile and an elevation of 600 ft.

In another system, endorsed by the French National Aerial League, each signal will consist of two numbers, indicating the distance in kilometers north or south, and east or west of Paris. These signals can also be used in combination with the ordnance maps.

The lines, figures and background may be painted, or be composed of coloured tiles, &c. Figures composed of silvered glass balls have been employed in experiments at the Eiffel Tower in Paris.

Some of these signs are illustrated in Figs. 1 and 2. The glass spherical ball has the effect of concentrating the light, a process which is aided by the silver backing, so that at a little distance the letters so made up stand out very brilliantly in daylight, irrespective of the direction from which they are seen. They could also be illuminated by artificial means during the night time (*e.g.*, by directing upon them the light from several powerful arc lamps).

A person possessing good sight can distinguish parallel lines, properly illuminated, when each line and space has an angular breadth of 1 minute, and can recognize Roman capital letters which subtend an angle of 5 minutes,

Hence the letters of signals for the use of aviators flying 1,000 ft. above ground, should be at least 16 or 18 in. high, and should be composed of lines at least $3\frac{1}{2}$ in. broad. These, however, are lower limits, which hold only for motionless, attentive, and keen-sighted observers. The aviator's acuteness of vision, like that of most persons, may be somewhat impaired, and if he is alone, his attention is distracted by the control of his machine; while, even a separate observer finds it difficult to recognize objects which he passes at a speed of 50 miles per hour, or 75 ft. per second. Hence the figures should be from

FIG. 1.—Showing a sign made of glass balls exhibited on the Terrace of the Trocadero, Paris.

FIG. 2.—Showing figures outlined in glass balls.

3 to 5 ft. high, and their lines from 7 to 12 in. broad. The "antique" capital letters and Arabic numerals adapted for oculists' use by the international ophthalmological congress of Naples in 1901, are the best for aeronautical signals. Although vision is more acute in the open air at noon in clear weather than in an oculist's examining room, it must be remembered that only one day in three is clear, that aviators prefer the relatively calm morning and evening hours, when mists are frequent and sun-light is less intense, and that the air above large cities is usually laden with dust and smoke. These conditions limit the colours used in signals to black and white, or very dark and light tints. As four or five men in one hundred are more or less colour-blind, coloured signals, which have caused many accidents on railroads and in navigation, should be rejected.

In Germany, it has been suggested to divide the country into districts, and to designate each district by a number and a letter, which would be exhibited on roofs or on signs suspended from captive balloons.

For the guidance of aviators and aeronauts at night a German inventor has devised a translucent red balloon about 8 ft. in diameter, containing an electric light of 100 candles or more, and moored by means of an electric cable.

These balloons are easily distinguished from other lights, and from stars, and can be seen from a great distance. Some are already used near Berlin for guiding the nocturnal flights of an advertising airship. It is clear that the design of these signs, and the method of illuminating them so as to be clearly seen from a distance, offers a fascinating field for study to the lighting engineer. Information is still required as to the order of brilliancy necessary to enable objects to be most easily seen at a certain distance, and the question of the *colour* of the light, as well as its brilliancy, may prove to be of considerable importance.

Correcting the Hefner Lamp for Atmospheric Moisture.

By F. K. Richtmyer

(Professor at Cornell University, Ithaca, U.S.A.).

One of the troublesome features of the Hefner lamp is the comparatively large correction on account of variation in atmospheric moisture. In laboratories where the Hefner is extensively used, charts are prepared from which these corrections may be made graphically. But where the lamp is used only infrequently one does not take the time to prepare a chart, and the correction (if made at all !) must be made by a rather long computation. For these latter cases the accompanying curves may be found useful.

One of the most common methods of measuring the moisture content of the atmosphere is by use of the so-called "wet-and-dry-bulb" thermometers. This method is used here. By use of Liebenthal's equation

$$y = 1{\cdot}049 - {\cdot}0055x,$$

values of the intensity of the Hefner were computed for wet-bulb depressions of 0°, 2°, 4°—16° Centigrade. This series of curves was then plotted with dry-bulb temperatures as abscissæ and the intensity of the Hefner in HK as ordinates.

For those who use the Fahrenheit thermometer, a conversion curve (the diagonal straight line) shows the value in Centigrade temperature of any Fahrenheit temperature.

To illustrate the use of these curves the following examples will suffice :—

Example 1.

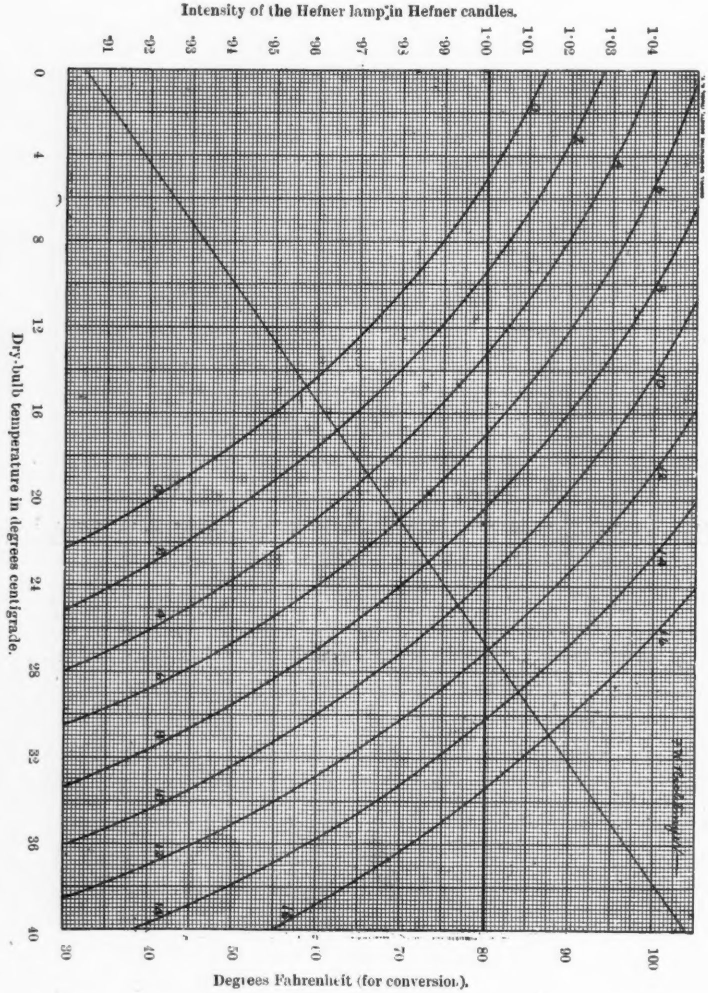
Dry bulb	18·4°C.
Wet bulb	15·2
Wet bulb depression ..	3·2
Hefner intensity ..	·967 HK

Example 2.

Dry bulb	75°F. = 23·9°C.
Wet bulb	68 = 20·0
Wet bulb depression ..	3·9
Hefner intensity ..	·937 HK

While these curves are not new—

in fact, they have been in use in this or similar form for a long time—they have perhaps not been widely published



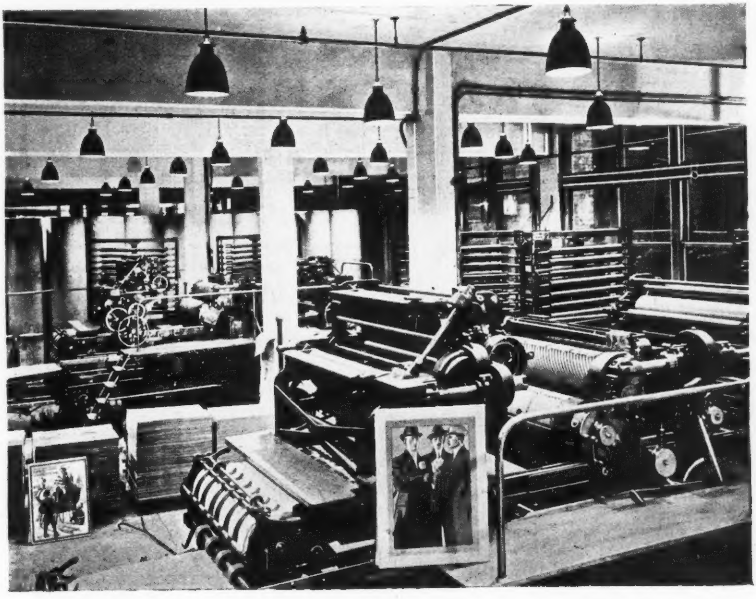
in a manner sufficiently accurate for computation. Furthermore, they bring out the fact that, under very ordinary weather conditions, the moisture correction may frequently amount to several per cent, a correction well worth looking after if one wishes even approximate results.

Short Notes on Illuminating Engineering.

From all Sources.

The Value of Reflection from Floors.

MR. J. R. CRAVATH, writing in *The Electrical World*, points out that very little attention is usually given to the question of reflection from floors, although the walls and ceiling generally receive some consideration when a lighting installation is being planned. This may be partly accounted for by the fact that, as a rule, it is impossible to guarantee a light-coloured floor; but that in certain cases the amount of light reflected from the floor may be quite considerable is evidenced in the accompanying reproduction of an untouched photograph, showing the lighting of part of a large printing works in Chicago. It will be observed that deep, opaque reflectors of the beehive type have been used, which do not allow any direct light to reach the ceiling. In spite of this, however, the ceiling appears quite bright, owing to the strong reflected light from the floors and the large stacks of white paper which stand near the presses. This system of lighting was installed after several preliminary trials with other methods. The effect is said to be quite satisfactory, and distinctly more cheerful than is usual with opaque reflectors.



High-Pressure Gas Lights on Brixton Hill.

THE photograph reproduced on the opposite page—for the use of which we are indebted to the courtesy of the Editor of *The Copartnership Journal*—shows an interesting recent high-pressure gas lighting installation outside the Lambeth Town Hall, Brixton Hill, in the district of the South Metropolitan Gas Co.

Prior to the high-pressure installation, it is stated, there were seventeen lanterns on columns fitted with thirty-five inverted burners. The total illuminating power of these lamps was rated at 4,200 candles. These lanterns have now been removed and replaced by eight single-burner Keith lamps, high pressure, 1,500 c.-p., and three Keith high-pressure 3,000 c.-p. lamps, thus making the total rated illuminating power 21,000 candles. The work of compression is at present being done by a $\frac{3}{4}$ h.-p. gas engine and a 1,000-ft. compressor, located in a house on the ground at the rear of the Town Hall. The pressure is stated to be 80 in.—truly a great change from the pressures current a few years ago!

It will also be observed that the candle-power is now reckoned to be just five times that provided before the change was made. This may be regarded as a striking illustration of the way in which the standard of illumination is rising in the streets of London.

The Multiplication of Technical and Scientific Societies.

IN these days we not infrequently hear the complaints that there are too many societies, and that it is impossible for an engineer to attend all the meetings he would like to do. From his standpoint this is doubtless provoking, but it may be argued that the multiplicity of societies is a natural and proper result of the development of scientific knowledge.

This view is taken by the author of the 'Engineering Notes' in *The Daily Telegraph*, who remarks: "The writer is often asked whether there are not too many of these technical institutions, and it must be confessed that they multiply at what must seem an alarming rate to those who are called upon for subscriptions. However, so long as they can keep up a really good interest in and keen discussion among their members, they are justified."

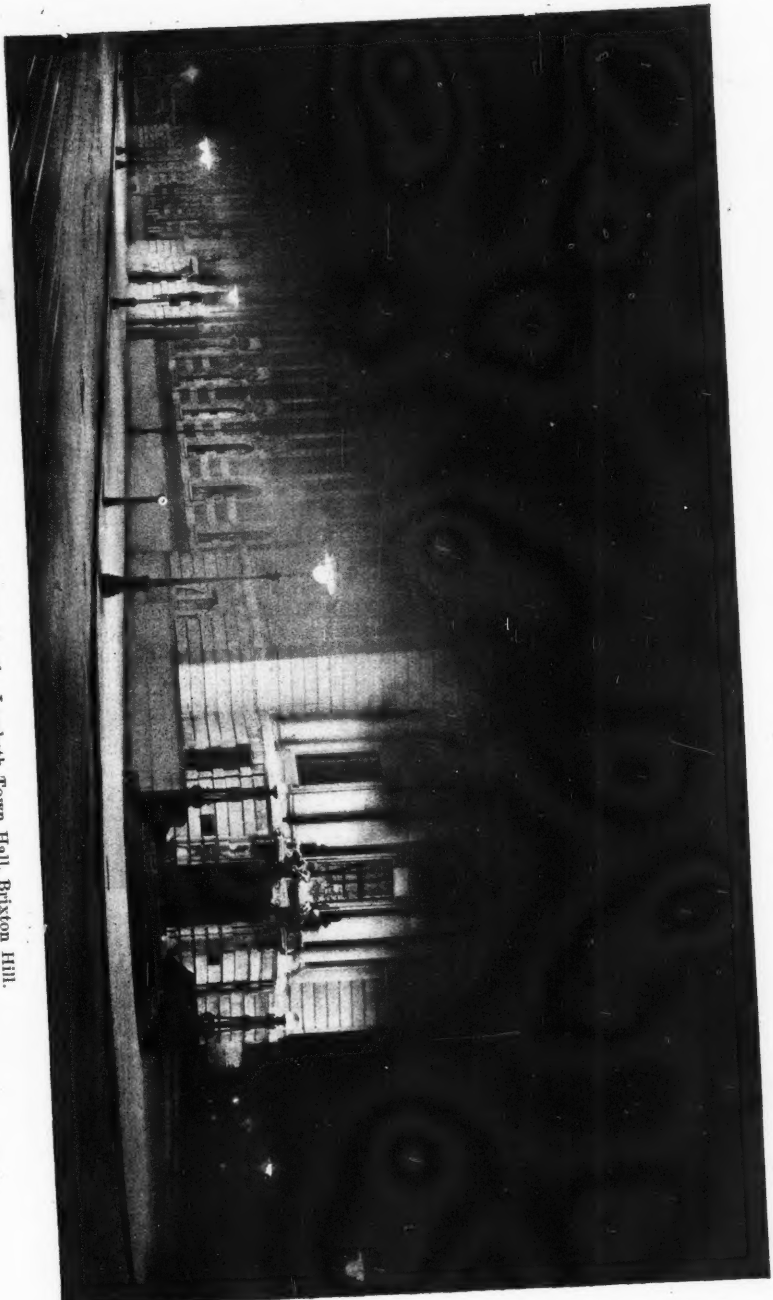
What is wanted, however, is better co-operation between these societies, so that their meetings may be available to all. The writer whose words we have quoted points out the advantages of a joint home, where all these meetings could take place and members of different societies could meet each other. Such a scheme has been actually realized in the United Engineering Societies' Building, provided by Mr. Carnegie in New York. An opportunity in this direction was lost when the Institution of Electrical Engineers was considering its new home a few years ago. Nevertheless, we may yet hope to see this ideal arrangement materialize in the not too distant future.

Mr. H. Kendrick on Maintenance.

IN a paper before the Manchester and Salford Ironmongers' Association, Mr. H. Kendrick made some references to the importance of maintenance of incandescent gas burners. Plumbers and gas-fitters, he said, must be trained to understand that nowadays they had to deal with apparatus based on scientific principals, and requiring far more knowledge than the older and simpler burners.

Careful maintenance of burners would ensure that they were well and regularly cleaned—a very important factor in good running. Corroded nipples, choked gauze, and broken mantles were frequent sources of inefficiency in burners which could be largely eliminated by good maintenance. Mr. Kendrick also advocated the use of adjustable nipples. By this means the quantity of gas could be adjusted exactly, and the flame could be made to fit the mantle.

The paper concluded with some interesting notes on heating by gas.



High-Pressure Gas Lighting outside the Lambeth Town Hall, Brixton Hill.

Lighting in the Grotto of the Nativity, Bethlehem.

An interesting feature of the decorations at the famous Grotto of the Nativity at Bethlehem is the illumination from a large number of hanging oil lamps, many of them of a very ornamental character, as shown in the illustration. These lamps are left as offerings by devout pilgrims, and provide another interesting illustration of the part played by light in worship.

Illuminated Sign to Indicate when a Letter Arrives.

The electric sign has recently been put to a novel use in some American hotels, where, as an additional luxury in the most fully equipped private rooms, an illuminated indicator informs the occupant that there is a "mail in the office for you." These words are painted on a small glass sign, so that they are only visible when illuminated by a lamp behind. The circuit of this lamp is connected up to the shutter closing the corresponding pigeon-hole in the letter-rack of the office of the hotel, so that when a letter is placed in the rack the sign in the room is illuminated, and the occupant is informed of its arrival.

Electric Light in a Hindu Temple.

According to a correspondent of *The Electrical Review*, electric lighting has recently been installed in the famous temple of Kali at Kalighat, Calcutta. The Hindu community in general is said to be very appreciative of the new mode of lighting, but some of the orthodox Hindus were at first somewhat doubtful of the propriety of introducing electric wires into the temple. After fully discussing the matter, however, it was decided to carry out the installation. It will be interesting, says the correspondent, to see whether electric light will eventually be installed in the great Juggernaut Temple.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Semi-Indirect Lighting.

The British Thomson-Houston Co. have recently produced a line of semi-indirect lighting fittings, with a view to filling the gap between direct lighting with prismatic glass reflectors and indirect lighting on the "Eye-Rest" system.

These fittings are supplied in two patterns of slightly different shape. One is intended for single lamps, and the

other for clusters of four or six Mazda lamps. The reflector bowls are made of a specially prepared opal glass, which transmits a small portion of the light, but throws most of it on to the ceiling, whence it is reflected evenly over the room. The opal glass of which the bowls are made is stated to have a very low co-efficient of absorption, and the waste of light is thus reduced to a minimum.

The special feature of the semi-indirect system is the visibility of the light source (at a greatly reduced brilliance), which gives a more familiar aspect to the installation and satisfies those who prefer to see something of the actual sources of light.

The British Thomson-Houston Co. have now developed three distinct systems of scientific lighting with Mazda Drawn-Wire Lamps, viz., direct lighting by means of Holophane and "Mazdalux" reflectors, semi-indirect lighting, and "Eye-Rest" indirect lighting. With such a variety as these systems provide, there is now no ground for the old complaint that artistic designs and efficient operation are incompatible.

Cord Resistances.

We have received from **C. Schniewindt** (Neuenrade, Westphalia, Germany), some particulars and prices of CORD RESISTANCES, for which there is a considerable demand. These resistances are made in two forms: (a) wire or flat-strip, wound on asbestos cord, and supplied in thicknesses ranging from 1·5 mm. to 5 mm., or (b) similar material, woven with asbestos strings, which can be supplied in any desired width, ranging from 5 mm. upwards.

Cord resistances are said to be particularly suitable for use in electric heating apparatus, where they can be run at a dull red heat without damage, and are practically unaffected by continual heating and cooling.

Ornamental Lamp-posts in Cast Iron

We note that the **Carron Co.** (Carron, Stirlingshire, N.B.) have recently produced some very beautiful CAST IRON LAMP STANDS for use at the South Shields Municipal Buildings. These are in the form of statues supporting lamps in their hands, and they serve to show that excellent detailed work can be produced in iron castings.

A New Portable Photometer.

We illustrate herewith Dibdin's HAND PHOTOMETER, a new form of portable photometer, which was exhibited by the makers, **Messrs. Alexander Wright & Co.** (1, Westminster Palace Gardens, London, S.W.) at the recent Optical Convention. A sliding contact is provided which varies the resistance to the lamp through a rheostat, and the readings can be checked by means of a small voltmeter, which is included in the equipment. The instrument, which is 15 in. long, 5 in. broad, and 5 in. deep, is designed to measure illumination, the scale reading in foot-candles.

"Lektrik" Lighting Connexions.

The above is the title of a little booklet we have received from **Messrs. A. P. Lundberg & Sons** (477–487, Liverpool Road, London, N.). It contains a very exhaustive series of WIRING AND CONNEXION DIAGRAMS and some explanatory notes by W. Perren Maycock. Among other points, the use of several special switches manufactured by the publishers is clearly explained, and we also note on p. 16 some remarks on illumination and switching, in which the convenience of control of lights is shown to be of great importance.

New Catalogues.

The British Thomson-Houston Co. have recently issued a list covering their very extensive range of WIRES, CABLES, AND FLEXIBLE CORDS for lighting and power work, &c. All B.T.H.wires and cables, it is stated, are manufactured according to C.M.A. specification and in both 2,500 and 600 megohm grades. The list is conveniently arranged, and should be welcomed by contractors and engineers who are in constant need of data and prices relating to all classes of wires and cables.

Copies of the above list will be sent to any one desiring it on application to the British Thomson-Houston Co.

As we go to press we have received from **Messrs. Siemens Bros. Dynamo Works** (Tyssen Street, Dalston, London, N.E.) several catalogues of lamps, &c., to which we hope to refer more fully in our next issue.

Personal.

Mr. Albert Jackson Marshall, who for the past seven years has been associated with the Holophane Company of America, in charge of their engineering department, and subsequently manager of their architectural department, announces his affiliation with Mr. F. Laurent Godinez, consulting lighting specialist, which took effect on July 1st. The firm's headquarters will be at the laboratory of Mr. Godinez, 123, Duncan Avenue, Jersey City. Mr. Marshall is known to our readers as secretary of the New York section of the American Illuminating Engineering Society, and is also a Corresponding Member of the Illuminating Engineering Society in this country.

We understand that it is the intention of the new firm to make a special point of co-operation with architects, decorators and lighting fixture manufacturers with a view to emphasizing the decorative side of lighting.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

THERE are not very many articles to record this month. Several editorials deal with the report just issued by the Chief Inspector of Factories, the special section by Mr. D. R. Wilson dealing with illumination being abstracted in quite a number of journals. The Optical Convention also receives attention, and the paper by J. S. Dow and V. H. MACKINNEY on **Recent Advances in the Measurement of Light and Illumination** is reproduced. The paper dealt with several new forms of photometric apparatus. Some novel applications of such instruments were described, not only in illuminating engineering, but for special purposes, such as the study of meteorological conditions and astronomical phenomena (brightness of sky, comets, eclipses, &c.), and as an aid in judging exposures in photography.

E. KLEBERT (*J.f.G.*, June 29) deals with **Illuminants for Lighthouses.** He describes the use of oil vapour at high pressure for powerful lights giving 600–2500 H.K. Such lamps consume about 0·4 gms. of petroleum per H.K. per hour. He also touches on the relative merits of oil-gas and electric methods of lighting in such cases. The matter resolves itself into a choice between a compact optical system and an elaborate electric apparatus for producing the light, or a larger signalling apparatus, but fed by oil-gas in a comparatively simple manner. Some data are also given regarding the needful intrinsic brilliancy (which with an acetylene-fed incandescent mantle may be as much as 100 H.K. per sq. cm.). The old question regarding the comparative merits of oil, gas, and electric light for penetrating mist and fog is not even yet completely settled.

An important matter is referred to in the brief summary issued of the Report of the Lichtmesskommission of the Verein f. Gas und Wasserfachmännern in Germany, for the present year. It had been proposed that the Zürich Photometric Commission should be extended so as to represent electricity as well as gas, and to deal more fully with illumination. But the view is expressed that this would be departing too radically from the original terms of reference of the Commission, and that it would be much better to form an entirely new **International Commission on Illumination** for this purpose.

Among other items we notice an article by W. W. COBLENTZ giving the **Emission Spectra of Neon and Helium,** which may prove of considerable use for vapour lamps in the future. The *Zeitschrift für Beleuchtungswesen* reproduces some humorous comments made by German newspapers in the early years of the last century on the introduction of gas for lighting, and the supposed difficulties to which it would give rise.

ELECTRIC LIGHTING.

The most interesting item in this section is the article by F. GIRARD on a commercial form of **Alternating Current Mercury Vapour Lamp** (*E.T.Z.*, July 4). This is rendered possible by making the tube in a V shape. The cathode, at the fork of the tube, is connected to the centre of the secondary of a transformer while the two anodes (the terminations of the V) are connected to the ends of the transformer winding. Under these conditions a permanent luminescence can be secured. It is, however, necessary to devise a starting arrangement which gives a repetition of "tips" in the event of the lamp not lighting up with the first rock given to it.

Among other articles we note that A. BAINVILLE discusses the **New Wire-Drawn Lamps** (*Électricien*, July 6). He alludes to the possibility of their being subject to a crystallizing effect which would tend to diminish their originally great strength in course of time. *The Electrical Review* of New York alludes to the American system of rating incandescent lamps at three alternative voltages, and points out that the highest of the three will almost always be correct. Other articles and letters in *The Electrical Times* deal with

the comparative costs of street lighting by tungsten lamps and flame arcs.

GAS, OIL, AND ACETYLENE LIGHTING.

A paper by BUNTE (*J.G.L.*, July 2), deals with the effect of varying composition of gas on the performance of incandescent gas lamps. The paper by V. R. LANSINGH on **Gas as an Illuminant** (*Am. Gaslight Jour.*, July 1), was noticed last month. There are several good examples of gas lighting described in the United States press. For example LEE *Prog. Age*, July 1), contributes an illustrated account of the **Lighting of an Art School,** the chief feature of which was the use of inverted mantles and deep conical opaque reflectors, so as to screen the mantles and throw the light downwards. Attention was also paid to the question of the right conditions of shadow for sketching from the cast. The same journal also contains some illustrations of **Gas Lighted Shops,** the best feature being the concealment of lamps, so that only the illuminated goods are seen.

NEUBURGER (*Licht und Lampe*, July 4) gives an account of the qualities of "**Blaugas,**" and its use for transportable lighting. He sketches out several schemes for lighting hotels, &c., by this means.

List of References:—

ILLUMINATION AND PHOTOMETRY.

Coblentz, W. W. Emission-spectra of Neon and Helium (*Z.f.B.*, June 30).
Dow, J. S., and Mackinney, V. H. Some Recent Advances in the Measurement of Light and Illumination (Paper read at the Optical Convention: abstracted, *J.G.L.*, July 2; *G.W.*, June 29).
Editorials. Factory Lighting (*G.W.*, July 6; *J.G.L.*, July 2).
Lighting of the House of Commons (*J.G.L.* July 2).
Klebert, E. Mitteilungen über Moderne Leuchtfeuer und Leuchtbojen (*J.f.G.*, June 29).
Bericht der Ver. f. Gas und Wasserfachmännern Lichtmesskommission (*J.f.G.*, July 6).
Beiträge zur Geschichte des Beleuchtungswesens: V. Spottbilder auf die Berliner Gasbeleuchtung (*Z.f.B.*, June 30).

ELECTRIC LIGHTING.

Bainville, A. La Nouvelle Lampe au tungstène à filament étiré (*l'Electricien*, July 6).
Editorial. Operating Lamps at the best Voltage (*Elec. Rev.*, N.Y., June 22).
Girard, F. Die neue Wechselstrom-Quarzlampen (*E.T.Z.*, July 4).
Street Lighting with Flame Arcs (*Elec. Times*, June 20, 27, July 4).

GAS, OIL, AND ACETYLENE LIGHTING.

Bunte, K. Effect of the Character and Composition of Gas on its Use (*J.G.L.*, July 2).
Lansingh, V. R. Gas as an Illuminant (*Am. Gas Light Jour.*, July 1).
Lee, J. D. Lighting a Philadelphia Art School (*Prog. Age*, July 1).
Neuburger, A. Das Blaugas—ein transportfähiges flüssiges Leuchtgas (*Licht u. Lampe*, July 4).
Store Window Lighting by Gas (*Prog. Age*, July 1).
L'Éclairage des Villes (*Rev. des Eclairages*, June 30).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
G. W.—*Gas World.*
J. f. G.—*Journal für Gasbeleuchtung.*
J. G. L.—*Journal of Gaslighting.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

Some Publications Received.

Building in London. By Horace Cubitt, A.R.I.B.A. (Constable & Co., 31*s.* 6*d.* net.)—We have already briefly referred to this work. It deals very clearly and fully with the law as it affects buildings, and contains a specially useful section relating to the Factory and Workshops Act. The points of the law as regards safety and hygienic conditions for workers are detailed in concise form, but we may expect to find that in future editions further reference to the question of lighting will be necessary under both these headings. Another important section deals with the construction of buildings. The rules regarding amount of air space and minimum window area are given, and illustrated with diagrams. On this latter question again we may expect to see more stress laid on the connexion between good light and good health in the future.

The Gas Light and Coke Company, 1812–1912.—This well got-up little book contains an account of the progress of the Company from its incorporation by Royal Charter in 1812 up to the present time. We have referred to it in greater detail elsewhere in this issue.

The Sensitiveness of the Eye to Colour and its Influence in Illuminating Engineering. By Dr. Otto Lummer.—In this pamphlet Dr. Lummer, who is an acknowledged authority on this subject, discusses with the aid of diagrams the physiological theory of colour vision. He points out its bearing on colour blindness, and also the important influence on the properties of commercial illuminants. The effect of artificial illuminants, in short, must ultimately be traced back to the behaviour of the eye.

The Influence of Illumination Conditions upon Eye-Strain. By Arthur J. Sweet.—This is a reprint of an address delivered before the Detroit-Ann Arbor Section of the American Institute of Electrical Engineers. Mr. Sweet's researches on this subject have already been partly made familiar to our readers in his analysis of street lighting requirements. (Vol. III. pp. 649, 705.)

On the Ultra-Violet Component in Artificial Light. By Dr. Louis Bell.—A reprint from the *Proceedings* of the American Academy of Arts and Sciences, giving an account of an investigation undertaken with a view to determining the proportion of ultra-violet in the spectra of various illuminants.

An Analysis of Glare from Paper. By M. Luckiesh.

Demonstration of the Simple Character of the Yellow Sensation. By F. W. Edridge-Green. (From the *Proceedings* of the Physiological Society, March 16, 1912.)—A monochromatic region of pure yellow can be isolated by means of the spectrometer. The wave-lengths of the boundaries of the region are recorded. The observer then puts on spectacles glazed with blue-green glass which is impervious to the red rays, and wears these for a short period. He then, whilst wearing the glasses, ioslates the yellow of the spectrum. It will be noticed that he isolates the same region as he did without the glasses. This would not be possible if the yellow and yellow-green regions affected a red and a green sensation; the green component being fatigued a region well into the green portion of the spectrum would be selected.

Journal of the Institution of Electrical Engineers.—The issue for May contains a paper by J. D. Morgan on 'Dynamos for Motor Road Vehicle Lighting.'

Journal of the Royal Society of Arts.—The issue for July 5th contains an account by Leon Gaster of the First International Congress for the Prevention of Industrial Accidents.

We also have to acknowledge the receipt of the following: *Journal of the Society of Architects, Science Abstracts, Journal of the Royal Sanitary Institute, Journal of the Rontgen Society, Bulletin of the Industrial Commission of Wisconsin, Proceedings of the Tokyo Mathematico-Physical Society, Jahrbuch der Radioaktivitat und Elektronik, Zeitschrift für wissenschaftliche Photographie Photophysik und Photochemie.*

9

ELECTRICITY · ACETYLENE · OIL · GAS

The ILLUMINATING ENGINEER

Edited by LEON GASTER

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EDITORIAL.

Sight Tests in the Mercantile Marine.

THE recently issued report of the departmental committee on this subject makes interesting reading. There appear to be about 100 collisions each year ascribed to "bad look out" (which might include the consequences of defective vision), and over 400 strandings due to causes which are not classified. Seeing that the number of voyages made by British merchant vessels during the year can hardly be less than about 300,000, the above percentage may not seem unduly high, but the recent loss of the "Titanic" reminds us that shipping accidents are apt to be particularly distressing when they do occur, and it is our duty to omit no means of reducing this number of casualties still further.

The point of chief interest to us is the percentage of mishaps due to defects of vision. Inquiry seems to have established very few cases in which mistakes could be clearly traced to this cause. But it is evident that there has as yet been no properly organized means of detecting and recording such cases. In this connexion the report remarks: "We do not think that it necessarily follows that the present method......has been successful in excluding all dangerous persons from the mercantile marine, or that no accidents have been caused in this way, since it has not been the practice in conducting inquiries into the cause of casualties to test the vision of persons implicated."

In the circumstances it is hardly surprising that little evidence of mistakes due to colour blindness or other defects of vision should exist. In this respect we are reminded of the circumstances connected with factory lighting. Here defective illumination is recognized to be "a grave

cause of danger," notwithstanding the limited statistics available. But it has not hitherto been customary to test the illumination when recording accidents, and until this is done it is difficult to establish the required proof.

We are glad to see that the very first of the series of recommendations of the Committee advocates that, in future judicial inquiries into causes of shipping casualties, witnesses giving evidence regarding coloured lights and signals should be tested for form and colour - vision. Another important suggestion is that in appeal cases an ophthalmic surgeon should be added to the present body of examiners.

The report contains a summary of the experiments they carried out, and the Committee has heard evidence from many well-known authorities. As regards form-acuity tests, there would seem to be fair general agreement. But on colour-blindness, it is well known, there is at present wide difference of opinion. We have before us an account, reprinted from the *Lancet*, of a case examined by Dr. Edridge-Green. In this instance the Board of Trade and other tests were successfully passed, and yet the individual examined is stated to be afflicted with "dangerous colour blindness." More than this, Dr. Edridge-Green mentions the perplexing case of a colour-blind Royal Academician who painted pictures in which the colours were faultless. On p. 436 we deal with a recent paper by the same author in which several other curious cases are mentioned.

It seems evident that specially elaborate tests are needed to distinguish all these different defects in colour-vision. The nature of the Board of Trade test is particularly important, because all our evidence is based on it; if this fails we are at once misled. Thus, if a man was wrongly passed into the service on a certain test, was responsible for an accident, and then was subjected to this same test again in the official inquiry following, his defective vision would probably never be established The Committee now recommend the adoption of the "lantern test" as supplementary to the wool-test. This appears to be a step in the right direction. Presumably in the case of an inquiry following an accident the examination would be specially exhaustive.

New Methods in Photometry.

Efforts are still being made to improve photometric apparatus and new instruments are constantly being introduced. Quite a remarkable series of novelties was shown at the recent Optical Convention in London. In the present number Prof. Rumi, of Genoa, describes a new form of photometer devised by him, and we notice that Dr. Sharp and Mr. Millar have just designed a new illuminometer in the United States.

But apart from such researches, which follow the orthodox lines of comparing the illumination to be measured with the light from a small calibrated standard within the instrument, there is a certain borderland of photometric research on which the more daring investigators are busy, namely, the use of so-called "physical methods" of measuring light. Naturally, apparatus of this kind must eventually be calibrated by appeal to the eye, but it may achieve simplification by making use of direct physical effects of light on matter.

From time to time attempts have been made to employ photography, but it is only recently that such efforts can be said to have come within measurable distance of practical requirements. Even now the problem is only more hopeful because we understand better what the limitations are and how they may be eventually removed.

In this country photometry has been successfully used as an aid to photographic work, *e.g.*, in judging the

exposure of photographs of artificially lighted interiors. The converse process—photography as an adjunct to photometry—has been less frequently essayed. The method has, however, been found of service in connexion with spectrophotographic work, the density of the negative being, under certain carefully determined conditions, proportional to the intensity of the light falling upon it. An ingenious use of this idea was made by Dr. H. E. Ives and W. Coblentz in their researches on the spectrum of the firefly. More recently Dr. Ives has proposed the use of photography as a means of obtaining polar curves of light distribution. A strip of sensitive paper is wound round the source in the form of a cylinder of large diameter, and the degree to which it is blackened may be proportional to the light in that direction. (Naturally great care must be exercised in selecting the period of exposure and conditions of development for this to be the case.) One of the advantages is that the process may be extended over a comparatively long interval, so that one automatically gets the mean result from a somewhat fluctuating source. The photographic paper, in short, acts like a "ballistic photometer." Useful as photography may be for certain special purposes, and in the hands of a skilled operator, it does not seem likely to be very widely used as a means of measuring light in illuminating engineering.

A more hopeful method, at first sight, is the use of a selenium cell. During the last few years much work has been done on such cells, and their peculiarities are now much better understood. They have now actually several industrial applications, and have even been used in photometry to a small extent, *e.g.*, in studying variations in daylight or the fluctuations in illumination during an eclipse. But their use would seem to be at present necessarily restricted to purely comparative measurements from one and the same source of light. The reason why this should be so is explained by some researches of Pfund, to which reference is made in the present number (p. 414). The distribution of sensitiveness throughout the spectrum is evidently quite distinct from that of the eye. Curiously enough, the sensitiveness to different colours alters with the intensity in a manner which is singularly like the "Purkinje effect" experienced by the eye. It is conceivable that a selenium cell may eventually be made to have the same sensibility curve as the eye, and to be sufficiently constant in operation. The careful work lavished on such cells by Ruhmer and others is bringing us appreciably nearer to this point.

One other form of physical photometer may be mentioned—namely the thermopile. This apparatus, of course, registers the radiant energy rather than the light, so that the maximum effect is usually far outside the visible spectrum. Yet some investigators have endeavoured to bring its sensitiveness into closer agreement with that of the eye by the use of suitable screens, and it has been used by Voege and others for strictly comparative measurements (*e.g.*, for studying fluctuations in arclamps) apparently with some success.

It is quite possible that some of these devices may play a more important part in photometry in the future. But it would seem that a great deal of patient research work must first be done.

Demonstrating the Value of Good Illumination to the Manufacturer.

The attention that has recently been devoted to the lighting of factories has not been without effect, and we find that the value of good illumination is now more readily conceded. And yet most people who have attempted to induce the manager of a works to adopt up-to-date lighting in place of some time-honoured and obsolete arrangement will admit that it frequently requires considerable powers of persuasion. It is usually conceded that the existing method is faulty but that

it will "do"—the fact being that in such cases the manager has no real conviction of the improved results which should follow. Not infrequently, too, the usual weapons of the lighting engineer, the arguments based on the brighter light, better distribution, and higher "foot-candles," do not convince the manufacturer. He finds it difficult to appreciate arguments couched in unfamiliar language, and distrusts terms which seem needlessly complicated and obscure. A man who has made a special study, not only of illumination, but of the class of business carried on in the premises to be lighted, is here at an immense advantage. Experience has taught him the circumstances in the trade where good lighting is really necessary, and his illustrations are appreciated at once.

A very practical suggestion is made by Mr. R. T. Kent in *Industrial Engineering* (see p. 423 in this number). He has found that the benefit of good illumination can be directly demonstrated by noting the time taken by various industrial processes, such as are repeated constantly, before and after a change in the lighting is made. In many cases even a small improvement in speed mounts up to a considerable saving in the course of a week, and affords direct evidence that the improved illumination has made the work easier. When the new system of lighting is installed in a portion of a factory on trial this method should yield specially good results. Another advantage of carrying out such time-tests is that they constantly add to the lighting expert's own experience. When he has accumulated data of this description he is in a much better position to approach other manufacturers in the same trade

In the same way it would doubtless be very useful, when possible, to obtain data as to the percentage of spoiled work before and after the change in illumination, and for his own information corresponding measurements of the light should be made. Not infrequently a manufacturer who is pleased with his lighting will make generous admissions of the benefit he has secured, and actual figures of this kind make the best possible arguments. To the lighting industry as a whole the publication of authentic figures of this kind would also be most useful.

Lighting Conditions in Mines.

The announcement regarding the award of the prizes recently announced by the Home Office for the best form of miner's lamp has now been made, and we hope that they have been instrumental in stimulating research on this subject. We recall that prizes of this kind were long ago instituted by the Royal Society of Arts in this country, and industrial competitions of this kind, designed to meet an acknowledged need, are deserving of every encouragement.

It is not surprising that the question of the miner's lamps should be receiving attention. Authorities seem disposed to believe that the presence of the disease of the eye termed nystagmus is at least partially due to poor illumination. We note that some interesting evidence on this point seems to have been brought forward by Dr. H. S. Ellworthy, of Ebbw Vale, at the Oxford Ophthalmological Congress held last July. He measured the surface-brightness of the coal (forming the surroundings of the miner) in various mines, and endeavoured to establish a relation between the brightness and the presence of nystagmus. It is interesting to note that according to these results the disease was most prevalent in those mines which were most feebly lit.

It would no doubt be injudicious to draw conclusions from experiments in a few mines only, and we await fuller investigations. But it certainly seems reasonable to expect that a connexion would be traceable between these unusual diseases and the peculiar sombre surroundings in which the miner's work is done.

LEON GASTER.

Review of Contents of this Issue.

THE first article in this number (p. 415), by PROF. RUMI, describes **A New Form of Photometric Apparatus for Measuring Illumination.** The essential point in the instrument is that it enables measurements to be made at any inclination by means of a detached screen. Prof. Rumi suggests that in determining the illumination at a table one should measure not only the horizontal value, but also the intensity in a vertical plane and at an angle of 45 degrees.

Following will be found the conclusion of the special report by MR. D. R. WILSON on the **Lighting of Factories.** Some general recommendations regarding the intensity of illumination required for various operations and the correct placing of lights are given, and the report concludes by some sketches of good and bad lighting arrangements. At the conclusion of the report is a contribution which contains the suggestion that measurements should be made of the time taken over industrial processes by good and bad illumination. By this means a much better idea of the value of proper lighting could often be gained by manufacturers who do not yet understand many of the terms used in illuminating engineering.

The account of MR. JOHNSTON'S collection of **Old Lamps** is also concluded (pp. 425–429). The present instalment deals with some odd forms of Chinese lamps, ingeniously constructed out of bamboo; a collection of old "crusie" lamps, many of them of Scotch origin; and a miscellaneous series coming from such remote countries as Ceylon, Japan, and Corea. Some old forms of church lamps are also included many of them of a very ornamental character. It is pointed out that while the design of all these lamps is, considered from a utilitarian standpoint, very primitive, their proportions were sometimes exquisite, and much might doubtless be learnt from the study of them by engineers of to-day.

The next article (p. 430) deals with the **Artificial Lighting of a Squash Rackets Court.** A photograph of the installation and data as regards the illumination provided are given, and it is pointed out that this game requires both absence of glare and an exceptionally uniform illumination. This is one more example of the value of artificial illumination for athletics, enabling many people who are engaged in business during the daytime to take part in rackets, tennis, &c.

On pp. 432–434 will be found an illustrated description of the **Lighting of the Pabst Theatre** in Milwaukee (U.S.A.). In the auditorium and in the passages indirect tungsten lighting is used, and the effect is considered very decorative. Particulars are also given of some tests on high candle-power tungsten lamps by A. Libesney, who finds that with the latest type a life of over 1,000 hours and a specific consumption of only 0·85 watts per candle can be obtained. In a note on a recent paper by Dr. F. W. Edridge-Green on 'Dichromatic Vision,' some curious cases of colour-blindness are described, all of which seem to belong to the above class. Interesting data were obtained from the examination of a man who became colour-blind but subsequently recovered, and a lady who was colour-blind in one eye, and not in the other (pp. 435–436).

At the end of the number will be found some **Short Notes on Illuminating Engineering, Reviews** of several well-known books, and the usual **Trade Notes** and **Review of the Technical Press.**

The Sensitiveness of Selenium Cells to Light.

A GREAT many investigators have studied the use of the selenium cell in photometry, but its applications are limited by the fact of its sensitiveness throughout the visible spectrum being quite different from that of the eye.

Some interesting researches on these points have been carried out by A. H. Pfund at the Johns Hopkins University (Baltimore, U.S.A.).* He remarks that, while every well-made cell experiences an increase in resistance for some time after it has been made, it eventually reaches a steady state, and a seasoned and properly constructed cell is a reliable instrument. Hysteresis (*i.e.*, the effect of previous exposure) is met with if the illumination is very high, but is not noticeable at moderate intensities.

As explained above, one of the chief difficulties in the use of selenium cells in photometry lies in the fact that their sensibility in different regions of the spectrum differs essentially from that of the eye. Prof. Ruhmer, who appears to have discovered how to control their sensitiveness in this respect, makes two varieties of cells, termed respectively "hard" and "soft." The former are sensitive to very intense light and comparatively insensitive to faint sources, while the "soft" cells behave in an exactly contrary manner. It is also stated that, whereas the maximum sensitiveness of the "hard" cells lies in the red, the corresponding maximum for the "soft" cells is located in the green.

It is possible to formulate an approximate law connecting the energy E of the exciting light and the resultant galvanometer reading D, namely, $D=KE^{B}$. The deflection D is a measure of the change in conductivity produced by the light falling on the cell. K is a constant. B is also a constant for a certain prescribed wave-length, being about 0·51 for violet and 1·00 for deep red. The relation between B and the colour of the light may help to explain the difference in behaviour of the soft and hard cells.

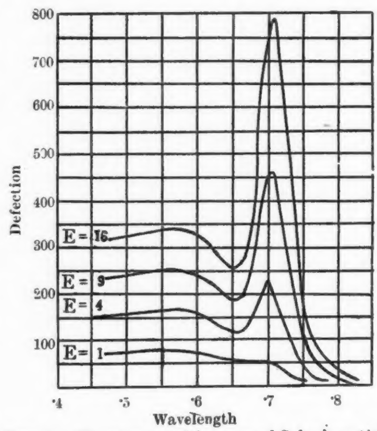


FIG. 1.—Showing sensitiveness of Selenium Cell throughout the Spectrum for Intensities in the Ratio of 1 : 4 : 9 : 16.

This characteristic of the selenium cell seems to account for the discrepancies in the results of past investigations, some authorities finding that greenish-yellow rays had the greatest effect, while others found that the red rays were most effective. The truth appears to be that the colour of light having most effect on the cell varies with the intensity. This is strikingly brought out in the accompanying diagram, showing the distribution of sensitiveness in the spectrum at intensities in the ratio of 1 : 4 : 9 : 16.

* *Phys. Review*, vol. xxxiv., May, 1912.

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

A New Form of Apparatus for Measuring Illumination.

By Prof. S. A. Rumi (Genoa).

In these days practical photometry, involving the comparison of the intensity of various sources of light, their colour and consumption, &c., and the calculation of the combined effect of a number of sources, has been carried to a fine art. But it is also now considered essential to make actual measurements of the illumination on the spot. In this way one can readily obtain data which it would be hardly possible to secure by calculations and

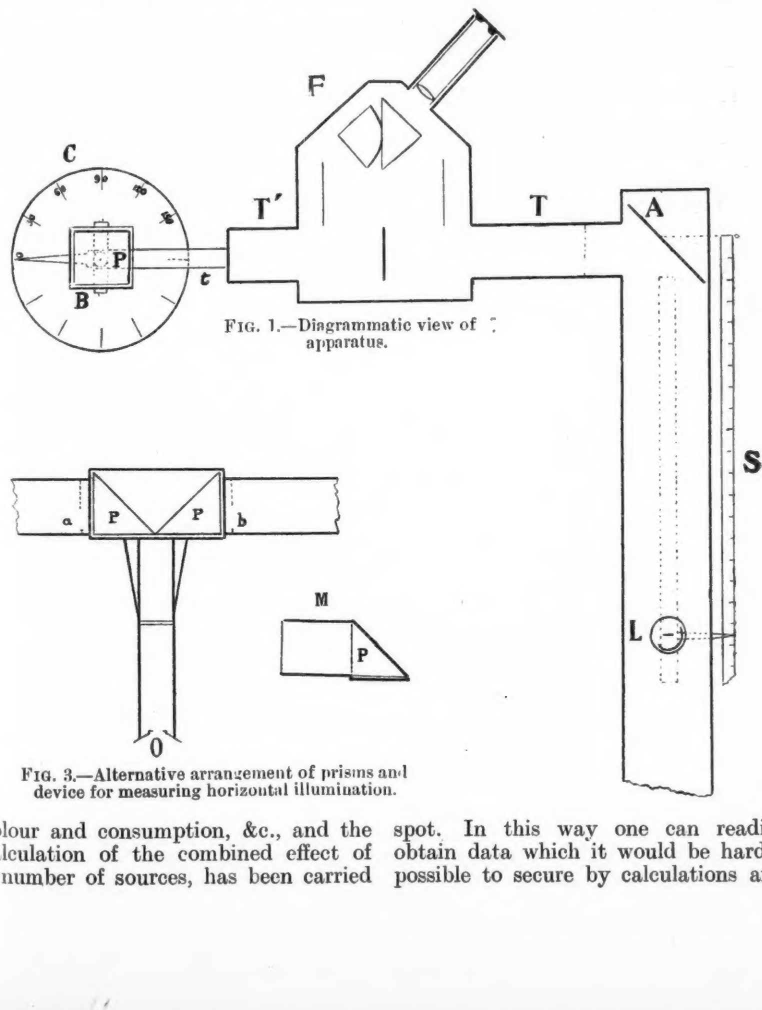


Fig. 1.—Diagrammatic view of apparatus.

Fig. 3.—Alternative arrangement of prisms and device for measuring horizontal illumination.

graphical constructions. For example, it is well recognized that the results of such calculations are greatly modified by the effect of reflection from walls and ceilings.

As an example of the use of instruments for this purpose, we may take

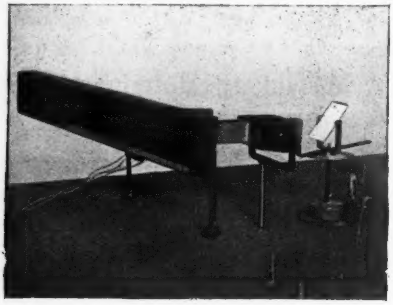


FIG. 2.—General view of instrument.

the Wingen photometer for the determination of horizontal illumination. But the readings of this instrument are somewhat easily affected by the variations in the height of the flame, and the shadow of the operator's body is apt to fall on the test-surface.

I have recently devised a form of illumination photometer (which I have

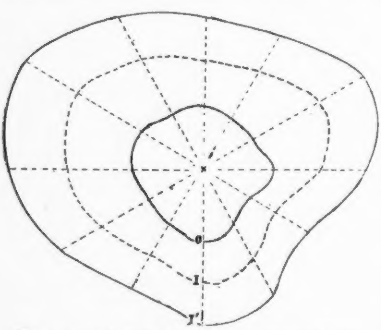


FIG. 4.—Distribution of illumination about a vertical axis.

described as a "photophasimètre") which is free from these sources of error, and enables one to measure the illumination on a surface whatever its inclination to the horizontal. In this instrument I have adapted the Lummer-Brodhun screen, as shown diagrammatically in Fig. 1. For strong illuminations one utilizes the ordinary magnesia screen provided with this photometer. For weak illuminations, however, it is preferable to substitute for this a glass plate, mirrored on both sides.

Fig. 2 shows a general view of the instrument. F represents the Lummer-Brodhun arrangement with lateral windows, to which are attached two rectangular tubes T, T′. The tube T leads into a longer tube at right angles to it, in which is situated a small incandescent standard lamp L, fed from two small accumulators. The position of the lamp can be adjusted

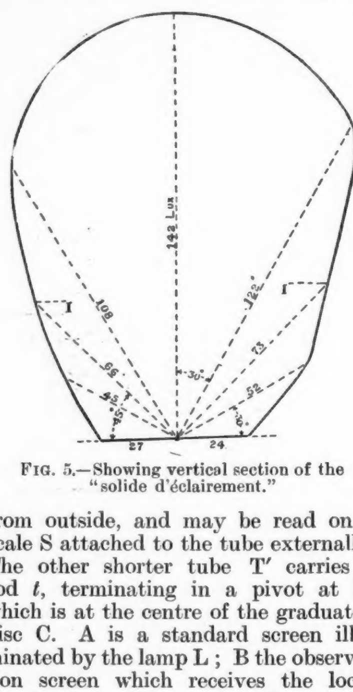


FIG. 5.—Showing vertical section of the "solide d'éclairement."

from outside, and may be read on a scale S attached to the tube externally. The other shorter tube T′ carries a rod t, terminating in a pivot at P, which is at the centre of the graduated disc C. A is a standard screen illuminated by the lamp L; B the observation screen which receives the local illumination. The screen B can be rotated about a horizontal axis, and the fork carrying it can itself be rotated about a vertical axis, so that it is possible to secure any desired inclination of the screen.

The apparatus shown at F may be replaced by the arrangement of prisms portrayed in Fig. 3, which enables us

to perceive images of the two screens through the rectangular apertures *a*, *b*. This device may be simplified still further by substituting two mirrors, inclined at right angles, for the prisms. In order to measure horizontal illumination one may replace the tube T′ by the arrangement indicated at M. This utilizes a 45 mirror (or a total-reflection prism) in order to reflect the light falling upon a translucent, horizontal observation screen.

In practice it is preferable to have the scale S calibrated direct in lux (bougie-metres), or in such a way that it is only necessary to multiply the reading by the candle-power of the standard. One can also make use of coloured screens if desirable; but it appears that the accuracy of reading is impaired to some extent by so doing. Some experiments carried out with screens of white, light yellow, and light and dark red tints showed that in the first two cases the difference between the readings was less than 5 per cent. But with the third-named screen deviations of as much as 8 per cent were observed, and with the others even more.

As explained above, the construction of this instrument enables one to measure at all possible inclinations, and thus to build up what Mascart has termed the "solide d'éclairement,"* having as its base the horizontal surface, and showing the intensity of all illumination in all directions. Such a solid will not in general be symmetrical. In Fig. 4 curve I shows the actual, and I′ the normal illumination on a surface inclined at 45 degs. and rotated about a vertical axis. O is the corresponding curve with the screen kept vertical. In Fig. 5, on the other hand, we have a vertical section of the solid, showing the asymmetry of the distribution of illumination.

One could, of course, replace such a diagram by a circle representing the equivalent mean illumination, but in practice this is not very readily or quickly done. The diagram, however, is a useful means of picturing the conditions of illumination received by a reader who can adjust the position of his book, or on an adjustable writing-desk. In practice the conditions of illumination are, perhaps, sufficiently known when one has determined the respective illuminations in a vertical and a horizontal plane, and in a plane inclined at 45 degs.

* v. 'Traité d'Optique,' by M. E. Mascart, vol. ii. p. 239.

Raising the Status of the Electrical Contractor.

A SERIES of regulations regarding electrical contracting appears to be on the point of being introduced in Chicago. It is proposed that electrical contractors and electricians should obtain a licence from the City Electrician before being entitled to carry out electrical work. By this means a check will be kept on the responsibility of those erecting installations, and a licence would doubtless be refused to a contractor whose work had been proved to be habitually of inferior class. As a means of raising the status of electrical contracting work, there seems much to be said for such an arrangement, and it is stated that the electrical contractors in Chicago are strongly in favour of it.†

It is also interesting to see that the Electrical Contractors' Association in this country have in view a somewhat similar scheme, the idea being that the Association should guarantee the work of members up to £50. Commenting on the proposal (which, we understand, was originated by Mr. Marryat), *The Electrical Times* remarks: "Such a scheme, with adequate safeguards for its effective work, should greatly raise the status of the electrical contractor and the prestige of the Association."

† *Electrical Review and Western Electrician*, June 29th, 1912.

Illumination in Factories and Workshops.

Notes on the Annual Report of H.M. Chief Inspector of Factories and Workshops for the year 1911.

(*Concluded from p. 384.*)

INDUSTRIES UNDER INVESTIGATION.

The industries investigated included cotton weaving, linen weaving, cotton spinning and preparing, flax spinning and preparing, composing rooms in letterpress printing works, machine rooms in clothing factories, and machine rooms in handkerchief factories.

(a) *Cotton Weaving.*—Here the lighting is uniform and symmetrical, being comparatively constant throughout the entire shed. The process is carried on almost exclusively in " sheds " or one-storey buildings with " saw-back " roofs, the short sides of which are glazed. The incidence of light is, therefore, vertical, and seeing that the work is in a horizontal plane, this is the best possible arrangement. Owing to the large expanse of window area, the " window-efficiency," as determined by the Trotter-Waldram method, is very efficient; in the table given by Mr. Wilson values up to 44-1000ths are recorded, but the usual range is from 16 to 35-1000ths. Generally speaking, the rows of looms run across or at right angles to the direction of the windows, but in sheds in certain districts they run parallel. The former is by far the better arrangement, since the light, coming sideways, throws no shadow on the work.

As regards artificial lighting, the object is again to produce a uniform illumination free from objectionable shadow. Lamps at a height of 6 ft. 3 in. to 7 ft. are commonly employed. Inverted gas lights, and particularly high-pressure systems, are being largely used, and the old flat-flamed .burners are being gradually replaced. The absence of shadow beneath the inverted mantle is a distinct advantage.

When electric glow lamps are used, 16 c.-p. carbon filament lamps are generally selected. Metallic filaments are rarely met with. There appears to be an impression that they are readily broken by vibration, but nevertheless they are common in the Irish weaving-sheds, where the vibration must be quite as great.

B. LINEN WEAVING.

The weaving of linen is carried on in sheds exactl: similar to those used for cotton weaving, and the conditions of daylight illumination are, therefore, substantially the same.

As regards artificial lighting, it is interesting to note that the reflecting power of linen is 30–40 per cent., whereas that of grey cotton is about 60–80 per cent. A more intense illumination is, therefore, generally found. Metallic filament lamps or high-pressure or low-pressure inverted gas lamps are usual, the allowance in general being one light per loom. This is fixed vertically above the stretch of cloth or immediately over the centre of the " loom-top " or highest point of the loom. In the latter event glare is liable to occur, and several instances were noted in which weavers had purposely diverted the lamps in order to shield their eyes. In Appendix IV. is shown a good example of lighting by means of deep shades, causing almost the whole of the light to fall upon the cloth. Sufficient light is diffused and reflected to illuminate the alleys satisfactorily.

C. COTTON-SPINNING.

Daylight.—Here we have an example of an illumination which is symmetrical, but more or less variable, as the light comes from side-windows, being mainly intended for the illumination of vertical planes. In modern mills the space between windows is made very small, so as to secure maximum glass area;

but, nevertheless, the ratio of window-space to floor area is often 1 : 12 or 1 : 20. Here, again, the windows are usually arranged to come at either end of the alley between the frames.

The general characteristics of the lighting are :—

(1) The window-efficiency is high at each end of an alley, but diminishes towards the centre, where it is frequently only 1-100th to 1-500th of that at the ends.

(2) The general illumination of the room increases with the height above the ground as the windows become less obstructed by adjacent buildings and more sky is visible.

(3) The window-efficiency at the centre varies according to the nature of the machinery. In roving rooms, containing frames with high creels, it is very low ; next come ring-spinning rooms ; the best lighted of all are the mule-rooms, with their broad alleys or "mule-gates" and relatively low creels.

Artificial Lighting.—The most common method of lighting spinning- and preparing-rooms is by carbon filament lamps placed at intervals along the alleys. In mule-spinning rooms each pair of mules is generally provided with two rows of lamps situated along the two sides of the mule-gate. The lighting of these rooms is generally better than any other room in the spinning mill, while the preparing-rooms are often the worst lighted. The part of the room containing the cards is often very insufficiently lighted, and may be even dangerous from the point of view of liability to accident. An illumination intensity below 1-100th of a foot-candle was sometimes recorded.

D. Flax-Spinning.

Daylight illumination is carried on under conditions very similar to cotton-spinning, but the rooms are narrower, the frames are set wider apart, and the ratio of window- to floor-area is, therefore, better.

Artificial lighting is mainly by metallic filament lamps suspended from the ceiling to within 3 ft. from the floor. The object is to illuminate the under side of the drawing rollers, a specially important point when breakage occurs. Lamps are protected by an outer covering of thick glass and iron bars.

E. Composing-Rooms in Letterpress Printing Works.

Daylight Illumination.—A specially good light is needed on account of the dark material and trying nature of the work. As a rule composing rooms in towns are badly lighted, except when situated on the top floor, where skylights can be provided. However, composing-rooms in many newspaper works are very little used during the day.

Artificial Lighting.—The fine nature of work and dark material demand a strong illumination. The reflecting power of the material appears to be only about 5–10 per cent. The usual method of illuminating the frames is by lamps a few inches above the upper case. In a few rooms inverted arcs are in use, and mercury vapour lamps have also been used. Unfortunately, glare is not always avoided, although it is very essential that this should be so. Several examples of good and bad lighting are given in the Appendix.

F. Sewing Machine Rooms in Clothing Factories.

Daylight Illumination.—Here, again, the work needs specially good light, but the obstruction due to machinery is much less than in other industries.

Artificial Lighting. — The artificial lighting is very efficient as far as intensity is concerned, but glare is often noticeable owing to the lamps being unshaded and too low. Two systems of lighting deserve notice. One of them involves the use of adjustable bracket stands carrying 8 or 16 c.-p. lamps protected with opaque metallic shades. Another system, which is sketched in the Appendix, utilizes small 4-volt glow lamps attached to the frame and provided with an appropriate screen shade concentrating the light on the needle.

Special care is necessary to avoid troublesome shadows in this work.

G. Sewing Machine Rooms in Sewing Handkerchief Factories.

Daylight Illumination. — Whenever possible machine-rooms are placed on the top storey, so as to be lighted efficiently by skylights. In some factories the machines have been transferred to specially constructed one-storey buildings for this purpose.

Artificial Lighting. — The artificial lighting is invariably good, the usual practice being to place the lamps at intervals down the centre of the table. In each room there is one table set apart for specially fine work known as "shiring," where the allowance of lamps is doubled. The lamps are generally well shaded, and glare is unusual.

Conclusions.

As was previously stated, for the perfect local lighting of work the three following conditions should be complied with: (1) The illumination must be adequate; (2) "glare" effects must be absent; and (3) no troublesome shadows must be cast on the work.

Adequacy.—In deciding on this point attention must be given to the class of work carried out, for a standard which would be quite sufficient for one class of work may be totally insufficient in another.

For this purpose work may be divided into two classes—"Inspective" and "Detective," according as the work entails continuous application of the eye to one small point or area, or consists merely in keeping a general watch over a given process, actual labour being demanded only when some fault occurs. Of the industries considered, the making-up of clothing and handkerchiefs and composing belong to the first class, and the second class comprises cotton and flax spinning and preparing. Weaving appears to be intermediate between the two classes.

As regards intensity of illumination, these classes are strongly distinguished, but the illumination also appears to depend on the fineness and colour of the material. In "inspective" work the eye is continuously applied to a small area, and it is specially important that there should be both adequate illumination and absence of glare. The following table gives a rough estimate of the illumination intensities provided for different classes of "inspective" work (artificial light):—

Industry.	Reflecting Power of Material (in per cent.).	Illumination Intensity (ft.-candles).
Clothing (machine rooms)	1—13	2–36
Handkerchiefs (machine rooms)	60—97	2—8
Composing Rooms	5 - 13	3–30
Cotton Weaving	60—80	1—5
Linen Weaving	30—40	3 - 18

It is difficult to state the minimum absolute illumination intensity necessary by daylight. Cohn has recommended 2·5 foot-candles for schools, and it was noticed that on several occasions an illumination of 1·5 foot-candles was regarded as inadequate.

For "detective" work the standard of illumination is much lower, and comes under the heading of general rather than local lighting. The area served is much more extensive, and the range from minimum to maximum illumination correspondingly great.

The following are the illuminations met with in factories for "detective" work:—

Industry and Room.	Illumination Foot-Candles.
Cotton Spinning.	
Preparing Rooms:—	
At Cards	0·01 to 0.7
At Combing Frames	0·1 to 2·0
At Drawing Frames	0·06 to 4
At Roving Frames	0·02 to 1·3
Ring Spinning Rooms	0·1 to 1·0
Mule Spinning Rooms	0·2 to 6·0
Flaxing Spinning.	
Preparing Rooms	0·2 to 1·0
Wet Spinning Rooms	0·6 to 3·4
Reeling Rooms	1·0 to 7·5

Glare.—In this respect the artificial lighting is often far from satisfactory, which is the more remarkable because the defect could usually be remedied without any difficulty.

For example, at a clothing factory the lamps were arranged in the customary manner in a row along the centre of the table facing the workers, the machines being arranged along either side. The needles were about 2 ft. 3 in. from the point vertically under the

lamp, and the lamps were about 1 ft. above the table. The angle of incidence was, therefore, 66°, and the "angle of glare" was about 43°. When the lamps were raised 1 ft., not only had the angle of glare increased to 60°, but, owing to the much smaller angle of incidence ($48\frac{1}{2}$°), the illumination at the desired point was actually more than before.

Glare is often pronounced in composing-rooms. In these the surface illuminated is usually vertically under the lamps, and these, therefore, cannot be raised without some loss of light; but, by making use of an efficient reflector, there should usually be no difficulty in setting the lamps at a

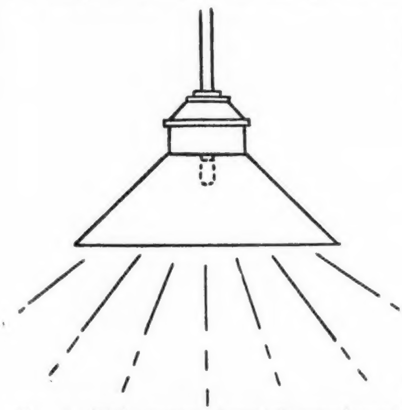


FIG. 1.—High pressure inverted incandescent lamp for lighting looms in linen weaving shed.

height sufficient to obviate discomfort. A still better method is to use a suitable deep opaque shade (see drawings in Appendix). Where very intense illumination is not needed, the best position for the units is undoubtedly high up behind and a little to the side of the worker. By this means both glare and inconvenient shadows can readily be avoided.

Shadows.—Shadows are sometimes troublesome in machine-rooms, especially where a whole group of machines is illuminated by a single powerful unit placed in the centre. Sometimes—*e.g.*, in composing-rooms—a troublesome shadow is cast by a neighbouring unit intended for an adjacent spot. Shifting shadows are particularly inconvenient.

Shadow-troubles are not usually met with in "detective" industries, where the illumination is less and the contrasts not so marked.

APPENDICES I–IV.

To these appendices we can only refer briefly, but the tabular data presented will doubtless be very useful for future reference. Appendix I. is devoted to a summary of the analysis of the premises visited for these measurements, comprising 160 rooms and 61 factories. The majority of these were cotton-weaving establishments.

Appendix II. and III. contain explanatory notes of the tables of daylight and artificial light which follow. In Appendix II. a series of eight tables, corresponding with the divisions A to G in the text, are assembled. They occupy eleven pages and are most exhaustive, full particulars of the area

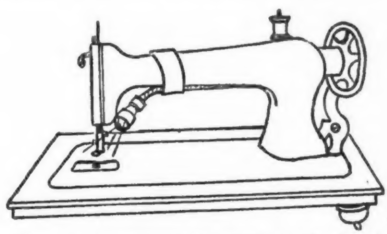


FIG. 2.—Arrangement of small 4-volt electric glow lamp for the local lighting of sewing machines. The source is so near to the point of work that a very intense illumination results (9 to 27 foot-candles). The system has the great advantage of casting the shadow of the needle holder in the right direction.

of rooms, window-space, illumination, and "window-efficiency" being given. On these tables the conclusions given previously are based.

Appendix III. (six pages) contains a similar series of tables giving particulars of the artificial lighting.

In Appendix IV. there are some sketches showing the good and bad systems of illumination, and these we reproduce.

In conclusion, it may be suggested that this report will be beneficial in showing how feasible measurements of illumination have become, and there is no doubt that they will do much to systematize factory lighting in the future.

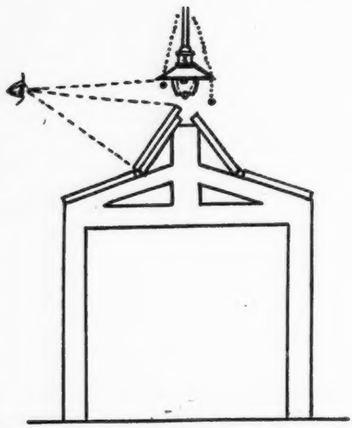


FIG. 3.—Imperfectly shaded lighting of compositors' frames by high pressure inverted incandescent gas. The incandescent mantle is just visible to a man of average height; the angle of glare is 40° at the lower, and 10° at the upper edge of the upper case. By extending the shade about 1 inch, all glare would be avoided and the illumination would not be diminished.

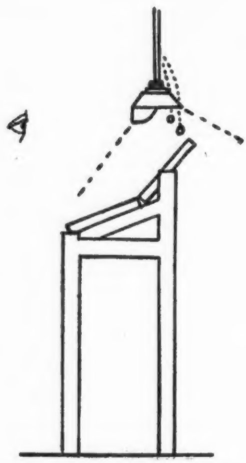


FIG. 5.—Good method of lighting compositors' frames by high pressure inverted incandescent gas. The eye is completely protected from the source by the provision of a semi-circular attachment to the conical shade.

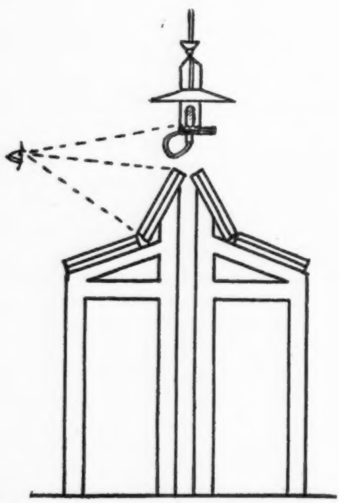


FIG. 4.—Imperfectly shaded lighting of compositors' frames by upright incandescent gas. The incandescent mantle is fully exposed to the eye and the angle of glare is 46° at the lower, and 16° at the upper edge of the upper case. The shadow of the compositor also is thrown on the frame by a similar unshaded source behind him.

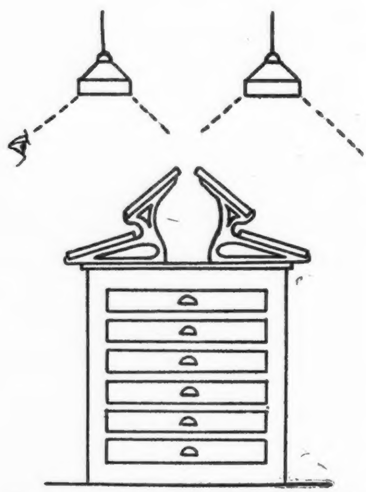


FIG. 6.—Good method of lighting compositors' frames by electric grow lamps. The eye is protected from the source by the cylindrical attachments to the conical shades. The general effect of the lighting is very restful owing to the absence of glare and of light in the top part of the room.

The Influence of Illumination on the Time Taken by Industrial Processes.

An interesting article by R. Thurston Kent, the fourth of a series on the principles of industrial lighting in a recent number of *Industrial Engineering*, suggests a simple and practical means of tracing the benefit derived from good lighting in factories.

Although many manufacturers recognize as an abstract truth that good lighting increases the efficiency of the worker, yet they have no ready means of proving its value numerically, nor observing how much better and quicker work can be done under improved conditions of illumination. Again the terms used in illuminating engineering are many of them quite unfamiliar to the average manufacturer, and he therefore does not always understand the data presented by experts.

Now Mr. Kent suggests that a more direct appeal could be made to the manufacturer by studying the time taken in various processes under different conditions of illumination. In this way the improved speed and efficiency of a particular operation secured by better lighting can be at once demonstrated, and it becomes unnecessary to run a plant or a department for an extended period in order to demonstrate the reduced cost.

The first point in making a time study, as proposed by the author, is to subdivide the complete operation into a number of simple movements. For example, it may be found that in setting a casting on a planing machine there are fifteen distinct movements, including the lighting of the piece from the floor, placing of blocks under it, levelling, setting and adjustment of the tool and the stops, &c. Each of these simple movements is timed independently with a stop watch, and the results are tabulated. The time required for each step under the old and new conditions of illumination is then accurately compared.

This method of analyzing one operation into its component movements has several advantages. There may be certain movements which take a very variable time, and are in no way affected by the lighting conditions, and these can be omitted when making up the totals for comparison. Again, the plan of timing in detail serves to show which of the particular movements are most affected by lighting conditions, and provides an indication of the directions in which improvement is most needed.

In order to form a really true estimate of the value of lighting, the time test can be repeated at different times of the day and with different workmen, an average then being determined. (Incidentally it may be mentioned that such time-studies as have been described may be of considerable use in fixing piece-work rates, though for this purpose too *average* and not minimum times should be taken.)

Some interesting results are given for the operation of setting a casting on a planing machine mentioned above. The average times for the various movements were determined under three different conditions of lighting.

1. With a single drop carbon lamp of 16 candle-power hung over the machine. These carbon lamps were suspended from cables, and could be moved to suit the operator, within a limited range.

2. A test was made with the same drop light, but with the addition of a central high candle-power gas lamp, which was situated in the middle of the room, and served to give a general illumination over several planing machines.

3. A tungsten lamp equipped with a steel reflector was suspended at a height of 7 ft. above the working plane, and in the position found to be most satisfactory for lighting the machine, and a further time-test was then carried out.

The following table gives the average times for the various movements under

the conditions described. Certain operations of a variable nature are omitted, as they obscure the conclusions to be drawn from a lighting test.

Average Time in Minutes occupied in Setting a Casting on a Planing Machine.

Operation.	One Carbon Drop Lamp.	Gas Lamp and Drop Lamp.	Tungsten Lamp.
1. Put piece on table	·18	·183	·183
2. Set piece in position	·136	·156	·176
3. Set blocks under end of body	·196	·173	·126
4. Level body	·38	·50	·253
5. Set one clamp at back	·186	·10	·186
6. Set two clamps at front	·353	·31	·31
7. Set four blocks under body	·336	·29	·293
8. Tighten three clamps	·406	·323	406
9. Take out finishing tool	·203	·253	·203
10. Move table	·116	·13	·126
11. Put in roughing tool	·446	·53	·516
12. Start machine, set cut	32	·286	·346
Total	3·258	3·234	3·124

Several interesting facts are brought out by this table. For example, although the intensity of illumination under the gas lamp (rated at 1,200 candle-power) was much greater than with either of the other systems of lighting, the average time for the operation detailed was longer than when the lamp equipped with a directive reflector was used. Such a fact as this might be used to make a direct appeal to a manager of works to consider the careful placing and shading of sources of light. For although the time saved on one small operation by one man may be measured as a decimal of a minute, it is obvious that the aggregate saving for a large number of workmen over an extended period would be very considerable.

The effect of shadows is also clearly emphasized by such an analysis as the above. Several operations took longer under the gas lamp, and in each case this could be directly attributed to the shadows thrown on the work. The minimum time with the gas lamp occurs, however, in operations performed on the top or back of the piece, where no objectionable shadows were cast, and the high illumination would be an advantage. The operations in which the minimum time is obtained under the single drop carbon lamp are those requiring no particular skill, and could probably be performed just as rapidly under any moderately good lighting conditions. The saving of time under the system of carefully directed and distributed lighting is most strikingly brought out in the process of levelling, where more care would be required than in most of the other operations.

It is suggested that the system of time-study would reveal some possibilities of economy in many other branches of industry. The author mentions as a further example the case of weaving in a textile mill. In a certain room of this kind a new installation of tungsten lamps, with appropriate reflectors and properly spaced, was set up for comparison with an old system of bare carbon lamps. At a rough estimate the speed of finding and tying broken thread by the weavers operating on the same class of work under these two systems was 60 to 75 per cent greater when working under the modern installation.

Value of Illuminating Engineering to the Gas Industry.

It is all to the good of the gas industry that closer attention is being directed to methods of lighting, and more particularly to the proper placing of the light units in factories, so as to avoid adverse effects upon the eyesight of operatives. If this matter is followed through, it cannot fail to bring the advantages of gas lighting into stronger relief.

The great importance of the competent illuminating engineer is emphasized by the comparison made in the recent report of the Chief Inspector of Factories between various trades. It is not so much a man with a diploma

that is required as an officer specially trained in the needs of the various trades in any particular district. In one district, for example, the woollen industry may preponderate, and it involves many processes, each requiring special consideration as to its lighting arrangements. In such an area it is very desirable that the gas undertaking should have on its staff a woollen mill lighting specialist.

So, too, where cotton, worsted, engineering, or other trades preponderate. Even if the lighting authority does no internal fitting, the offer of expert advice is almost invariably appreciated, and in any event it is "up to" the gas industry to see that gas under the best circumstances has due consideration, especially where the lighting is competitive. The lighting representative who undertakes such duties can only acquire the proper degree of competency by combining sound theoretical knowledge with a close personal study of the particular processes in the lighting of which he is called upon to advise.—*Gas World, July 6th.*

Light from the Earliest Times.

An account of some lamps in the collection of Mr. J. W. Johnston (Fellow of the Society of Antiquaries of Scotland), and of a lecture recently delivered by him on this subject.

(*Concluded from page 393*).

Our next illustration (Fig. 4) shows some lamps of an entirely different character, coming from China. Some of them are made of bamboo, and put together in a highly characteristic and ingenious fashion. Of special interest is the chair for supporting the lamp. This can either stand on a flat surface or hang on a nail on the wall. There is also a contrivance beneath the lamp proper to catch any oil that may drip over.

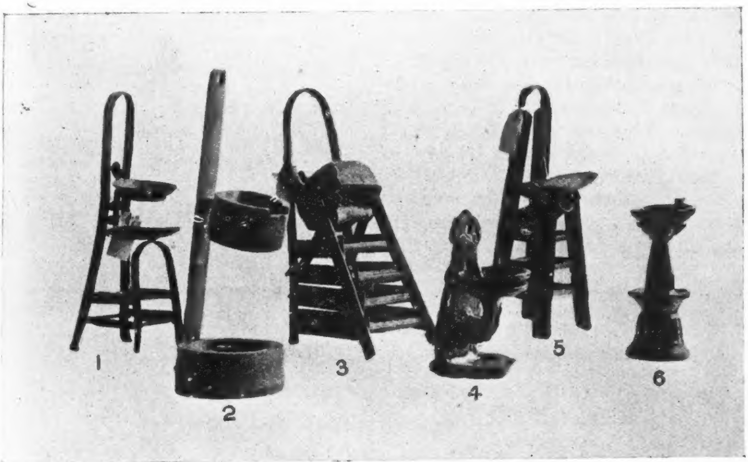


FIG. 4 – Group of Chinese Lamps. (6 Specimens.)

(1) Chinese Sheet Iron Chair-Shaped Lamp.
(2) Primitive Chinese Bamboo Lamp.
(3) Chinese Bamboo Chair-Shaped Lamp, from a Canton river boat.
(4 and 6) Chinese Brown Glaze Earthenware Lamps.
(5) Chinese Bamboo Chair-Shaped Lamp.

Nos. 1, 2, and 5 figured in the *Proceedings* of the Society of Antiquaries of Scotland, 1887-8.

We now come to the "crusie" lamps, a fine collection of which is shown in Fig. 5. The name "crusie" (cf. "cruse") is really local, being applied to this particular variety of flat metal lamp in Scotland. But it may be used to describe the general type. These lamps, it will be seen, consist of simple shallow receptacles with spouts at intervals round their rim, from which wicks project. In Scotland they were almost invariably the work of village blacksmiths, being made of beaten iron. These crusie lamps are, however, common to almost all nations, being found even in some of the catacombs of Rome. Their essential form appears to have been retained practically unchanged for centuries, and there are specimens which are known to have been used in the same family for several hundred years. Being made of iron, they would be practically unbreakable. Specimens made of tin, bronze, brass, and copper, and even stone, can also be seen, and in Mr. Johnston's collection such lamps, from Holland, Norway, North Italy, and even Colombo and North Borneo, are included. It is striking to observe how exactly the characteristic form is repeated in different countries. Presumably the types found in remote districts were based on specimens imported from Europe. It is curious, however, how each country contrived to give its impress to the design of the lamp, the ornamentation of the Scottish lamp generally taking the form of the blackcock's tail, while the specimens from Norway have the general form of a boat.

FIG. 6.—Various special types of Crusie Lamps.

In Fig. 6 are to be seen several additional specimens of Scottish Crusie Lamps. The specimen with the long handle, which comes from Lanarkshire, is very interesting. It is really a combination of crusie and candle-holder, such as was frequently used by bakers. The other specimens come from Aberdeenshire, Kincardineshine, and Invernesshire.

Particulars of lamps shown in Fig. 5:—

(1) Iron, shell-shaped crusie, Northern Norway, used in the fishing districts.
(2) Copper Crusie, Orkney, made from copper from a wrecked ship.
(3) Iron Crusie with Lid, Aberdeenshire, ornamentation, blackcock's tail, the favourite design of Scotch crusies
(4) Sheet Iron Crusie, with 4 spouts, from the late King's Kraal, Benin.
(5) Iron Crusie, Shetland.
(6) Iron Crusie, Italy, beautifully engraved.
(7) Iron Crusie, Scotch, round, unusual shape of Scotch crusie, Lanarkshire.
(8 and 9) Tin Crusies, Spain.
(10) Wrought Iron Crusie, Italy.
(11) Sheet Iron Crusie, France, ornamentation, cock.
(12) Iron Lamp, in form of Hippo-sandal. Dug out of river Orwell.
(13) Iron Crusie, Germany.
(14) Pierced Iron Lantern, with 5 bull's-eyes, Kincardineshire. Similar lantern portrayed in J. F. Herring's picture "Nanny," now in Blackburn Art Gallery.
(15) Temple Lantern, Japan.
(16) Stable Lantern or "Bowit," Banffshire, with candle-holder.
(17) Bronze Lamp, in shape of foot with sandal, fourth century.

Remainder of collection are mainly Scotch Crusies, obtained from Islay, Inverness, Aberdeen, Banff, Kincardine, and Lanarkshire.

FIG. 5.—Collection of Crusies, and a few other Lamps. (69 Specimens.)

(For reference to figures, see opposite.)

The Scottish crusie, like many of the European lamps, was provided with a lower receptacle to catch the drippings of the oil. Another device was a projecting ratchet, by which the flow of oil in the vessel could be regulated to the wick. In some cases the upper receptacle was provided with a lid. When in use the crusie was commonly hung by the iron hook at the back. The wick was usually of the rush-pith or worsted yarn, and the oil was of home manufacture, extracted from fish or mutton fat, and usually very coarse and rank. In Japan oil extracted from nuts was used, and in Nigeria vegetable oil termed "Shea butter." As an illuminant the crusie was anything but ideal. It frequently gave rise to an unpleasant acrid smell, owing to lack of proper access of air to flame and incomplete combustion. It required constant trimming and attention, and the light was of a feeble and flickering character. Until the middle of the last century the crusie was in general use in Scotland, when it was eventually superseded by the paraffin lamp.

Several other items in Fig. 5 call for mention. No. 15 is an interesting lantern from a temple in Japan, No. 14 a pierced iron lantern with five bull's-eyes from Scotland. There is also an example of the fantastic form of bronze lamp, in the form of a sandal similar to those described in the old work by Dom Bernard de Montfaucon in 1719. The stable lantern, or "bowat," comes from Banff. One of the most interesting in existence is the original lantern of Guido Faux, now in the Bodleian Museum at Oxford.

The last illustration (Fig. 7) shows a miscellaneous collection of brass lamps, many of them crusies from various countries. A particularly elegant piece of work is the Etruscan lamp, No. 14, and No. 11, the nine-light "Chanukah" lamp, has an interesting significance in view of its association with the Hebrew Chanukah festival to celebrate the deliverance from Syria under Judas Maccabæus. In these ceremonies the kindling of lamps forms an important part of the ritual.

There is doubtless much to be learned from the beautiful proportions and ingenious devices met with in many of these old lamps. The lighting engineer of to-day, who is so often occupied in the problem of introducing new illuminants amid old surroundings, would often find it of benefit to bear in mind the influence of tradition, and to imitate some of the graceful lines of appropriate ancient fixtures. Our present illuminants, considered from the purely utilitarian standpoint, are doubtless far more efficient. But it may be questioned whether they receive the same deliberate care from the artistic standpoint as was lavished even on the simplest forms of lamps in the past.

In conclusion, we must express our great appreciation of Mr. Johnston's kindness in granting facilities for the writing of this article, and we have also to acknowledge the assistance of Mr. Val. H. Mackinney, to whose skill the excellent photographs of the collection are due.

Particulars of lamps shown in Fig. 7:—

(1, 2, 3, 4, 5) Occur in Fig 3.
(6 and 7) Brass Hanging Lamps, Japan, Pith of Rush used as wicks.
(8) Brass Crusie Lamps, Colombo.
(9) Brass Crusie Lamps, Holland.
(10) Brass Crusie Lamp, beautifully engraved, Morocco.
(11) Brass Chanukah Lamp, 9 lights, from Jewish Tabernacle.
(12) Brass Candle Lamp, pierced and engraved, Jaipur, India.
(13) Brass Figure Standard Lamp, Italy.
(14) Etruscan Lamp, bronze, column with serpent entwined, standing on three cloven hoofs, period 300 B.C., found in Thebes.
(15) Brass Lamp, 3 wicks, on iron standard, Syria.
(16) Brass Standard Lamp, 2 wicks, Portugal.
(17) Brass Butterfly Candle-holder, Seoul, Corea.
(18) Small Brass Table Lamps, Japan.
(19) Brass Tinder Boxes, Holland.
(20) Brass Pricket Candlestick, Japan.

Others figured represent specimens from Venice, Rio Tinto, Malta, Jerusalem, Bruges, &c.

FIG. 7.—Collection of Brass Lamps and Tinder Boxes. (52 Specimens.)

(For reference to figures, see opposite.)

The Lighting of a Covered Squash Racket Court.

It will be recalled that rather more than a year ago we described the lighting by high-pressure gas of the covered lawn tennis ground at Dulwich. By the courtesy of Mr. H. M. Rootham, B.Sc. A.M.I.C.E. we are now enabled to describe the lighting of a covered squash racket court, likewise constructed by him, for Mr. P. T. Perkins in Camden Square.

Squash rackets is a game played in a court of comparatively small size, and artificial lighting is therefore quite a simple matter. The size of this court is 30 ft. by 21 ft. by 14 ft. Daylight is supplied by a partly glazed skylight, and the walls are made of cement, and specially designed to give an elastic surface and produce a fast game. The rapidity with which the small ball used in this game travels calls for a very perfect system of artificial illumination.

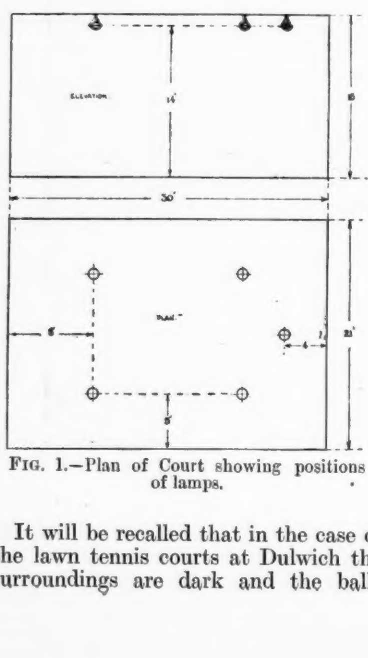


FIG. 1.—Plan of Court showing positions of lamps.

It will be recalled that in the case of the lawn tennis courts at Dulwich the surroundings are dark and the balls white. Here, on the other hand, the ball is black and the walls, ceiling, and floor a dead white—a state of affairs which naturally assists the evenness of illumination considerably. In fact, the conditions are not unlike those met with in the Ulbricht sphere used in photometry. The general nature of the court and the arrangement of the lights will be understood from the plan shown in Fig. 1 and the photograph on the opposite page. By daylight abundance of illumination is readily secured, but to improve the diffusion of direct sunlight it is possible that muslin blinds may be added. The artificial light is provided by five Holophane stiletto 10-inch Reflector Bowls, each containing a 50-watt tungsten lamp, and spaced as shown.

These lamps are placed at a height of 14 ft., well above the region of the wall used for play, and are found to give no trouble whatever to the players. In rackets the ball ricochets rapidly round the walls, and can be taken after bouncing off any of the four walls by the players. It is therefore essential to secure a perfectly even illumination, not only over the floor, but over the walls as well. Tests of the surface brightness of walls and floor showed that values ranging from 0·9–1·2 foot-candles were obtained—a very satisfactory result in view of the fact that the lamps are placed so high, and the consumption of energy is only about 0·5 watts per square foot of floor area (under one-third of a unit per hour).

It is interesting to note how the use of artificial light, as a means of enabling games to be played in the evening, is spreading. In the case of such a game as squash rackets, played in a small space, and in a court which is preferably covered, the possibilities of extending the hours of play in this way seem very great. The recognition of the ease with which such courts can be

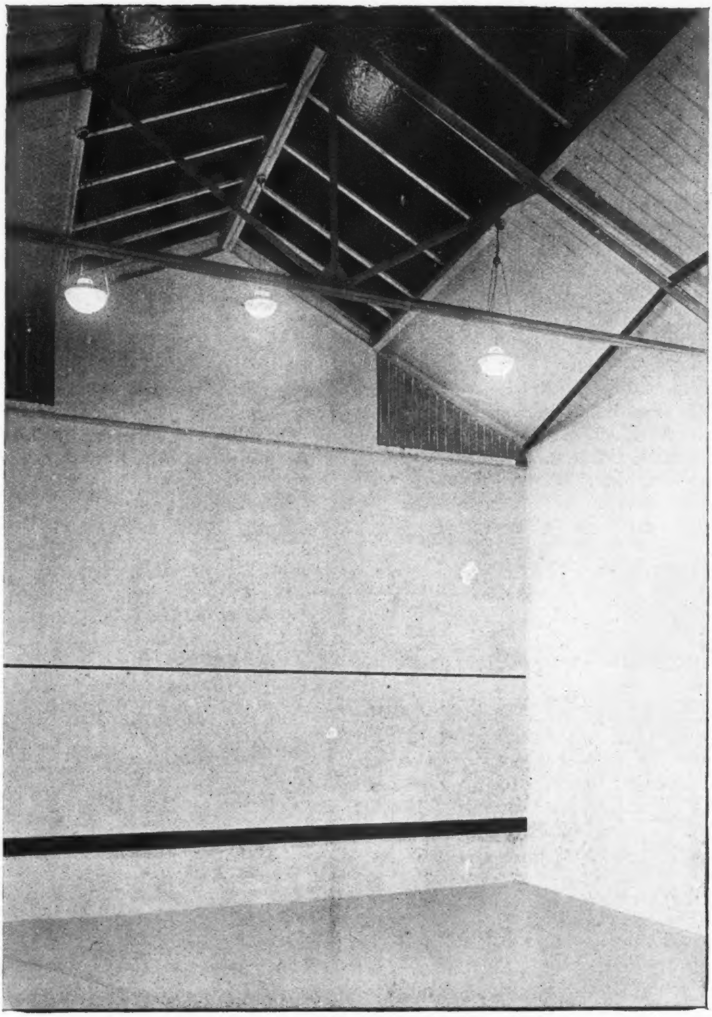


FIG. 2.—Photograph of Racket Court illuminated by Holophane bowls.

[*Taken from serving end, entirely by artificial light.*]

lighted artificially should lead to quite a number being erected round London, and may be the means of inducing many people who are occupied with their business in the daytime to devote some of their evening time to athletics.

Co-Operation between British and American Illuminating Engineering Societies.

A SPECIAL meeting of the New York section of the American Illuminating Engineering Society was held on August 1st, when an address was delivered by Mr. Leon Gaster on 'Progress in Illuminating Engineering in Europe.'

An outline was given of the work so far done in connexion with glare, school and library lighting, education in illuminating engineering, and other subjects, and it was pointed out how valuable had been the influence of the Society in bringing home to authorities the importance of good factory lighting.

The local conditions have naturally moulded the line of development of the British Society. Its international connexion, Mr. Gaster pointed out, should enable it to act as a centre in Europe and as a connecting link between the American Society and the various Continental bodies with which it desires to get in touch. The time is ripe for closer co-operation between the two bodies.

Dr. Sharp recalled that at the time of the starting of the British Society the American Illuminating Engineering Society sent a cablegram of congratulation, and at the special meeting on August 1st these good wishes were renewed. Some remarks were also made by Mr. A. J. Marshall, Mr. L. B. Marks, Mr. Norman Macbeth, Dr. H. E. Ives, and Mr. D. Macfarlane Moore, all of whom have been closely associated with the movement, likewise expressed their appreciation of the work done in the short time during which the British Society has been in existence.

Indirect Tungsten Lighting in a Theatre in Milwaukee.

A VERY interesting description of an indirect tungsten lighting installation in the Pabst Theatre of Milwaukee, U.S.A., recently appeared in *The Electrical World*.* By the courtesy of the editor of this journal we have been favoured by some photographs taken by artificial light, showing the nature of the illumination. These are reproduced in Figs. 1, 2, 3, and 4.

Fig. 1 shows a general view of the fixture used in the auditorium. The diameter of the huge suspended reflector bowl is 7½ ft., and it contains tungsten lamps consuming in all 5,000 watts. As the ceiling above is dark in tint, it was found necessary to suspend the fixture from a moulded white disc 12 ft. in diameter, this disc forming a good reflecting surface to send the light downwards. The same system

FIG. 1.—Large indirect lighting unit suspended in the auditorium.

* Dec. 23, 1911.

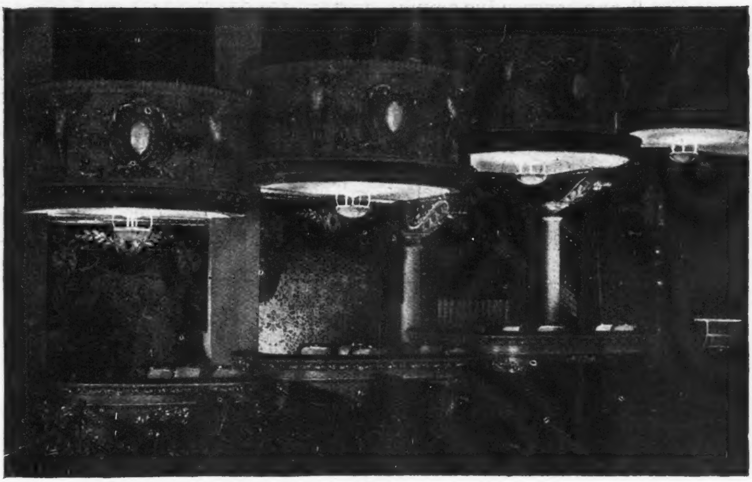


FIG. 2.—Showing indirect units for lightiug the boxes.

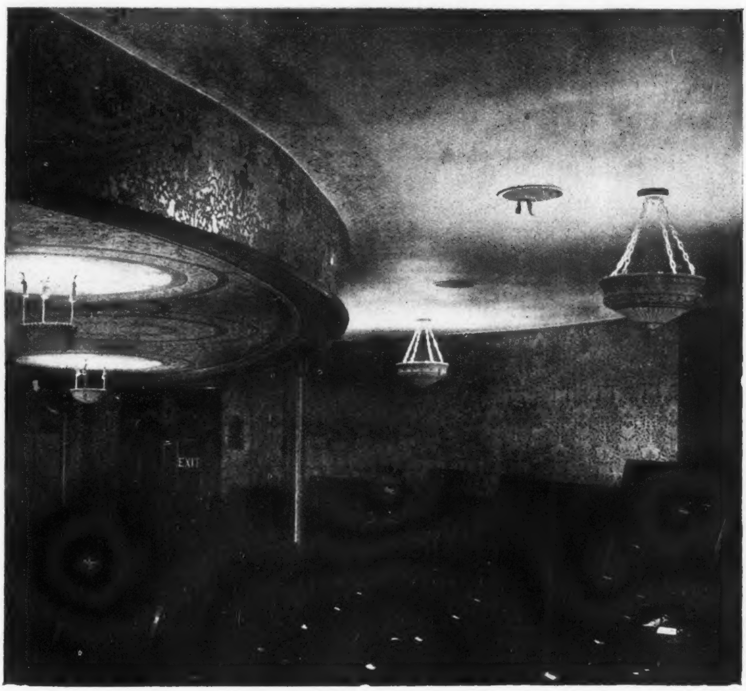


FIG. 3.—Showing indirect lighting under the amphitheatre.

is carried into effect in the boxes, as shown in Fig. 2, and beneath the amphitheatre (Fig. 3). These smaller bowls each contain a 60-watt tungsten lamps, in some cases an artistic effect has been aimed at by replacing the usual metal chains by plaited silk cords.

A specially interesting effect is also secured in the foyer (Fig. 4), where the indirect units are placed each below its respective domed ceiling. There are, of course, also special local lights for the cashier's desk, &c., and the usual footlights and border-lights for the production of a strong stage-illumination. Measurements of illumination showed that the horizontal illumination on the stage was of the order of 2½ foot-candles in the front of the stage, mounting up to about 6 at the rear. The vertical illumination, however, diminished from about 14 foot-candles at the front to 4 foot-candles in the rear, and it is suggested that this difference has a bearing on the effect of perspective desirable on the stage. In addition, the Pabst arc "spot-lamp" operated from the balcony was capable of giving an illumination of 85 foot-candles when used in this way, and 2½ foot-candles when utilized as a "flood light" (for distributing the illumination).

There are also the prescribed number of "panic" or emergency lights mounted in a row over the proscenium, and separately controlled. For the exit lights wax candles furnish an additional independent source of illumination.

FIG. 4.—Showing the effect of indirect lighting in the foyer.

The lighting fixtures in this theatre were furnished by Mr. G. Kuehn, with the exception of the very large main inverted dome, which is a replica of the one in the Eighth Church of Christ, Chicago*, and was furnished by the National X-Ray Co.

* See *Illum. Eng.*, Lond., April, 1912, p. 168.

Improved Efficiency of High Candle-Power Tungsten Lamps.

By A. Libesney.*

* Paper presented at the meeting of the Vereinigung der Elektricitätswerke in Magdeburg, June 19th to 21st, 1911.

In an interesting communication on this subject, Herr A. Libesney reviewed the progress so far made in improving the efficiency of tungsten lamps. Efforts are continually being made to reduce the specific consumption of these lamps below the usual figure of 1·1 watts per H.K. But in the case of lamps of ordinary candle-power (up to 50 H.K.), it is at present difficult to make any definite progress in this respect without unduly shortening the life. As an illustration of the results obtained in such cases, Herr A. Libesney presents the following set of curves as in Fig. 1.

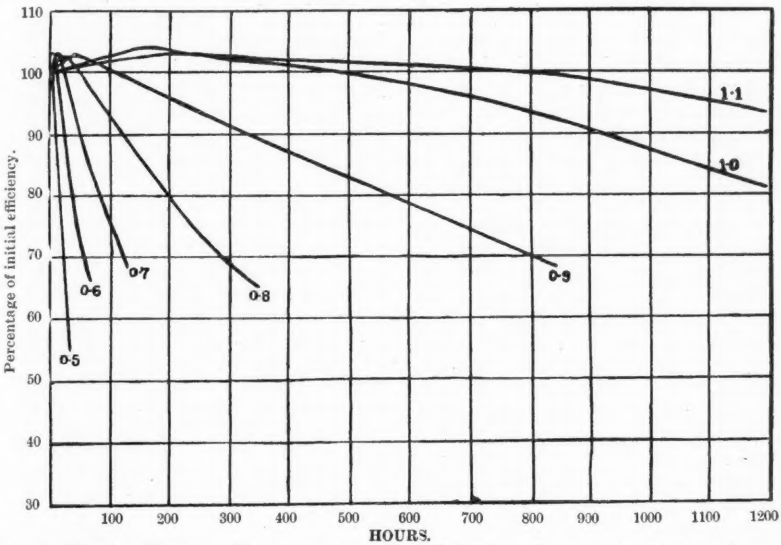


Fig. 1.—Showing life tests of lamps run at various efficiencies. Figures attached to each curve indicate watts per H.K.

In the case of the high candle-power lamps, however, the possibilities in this direction are greater owing to the stouter filament employed. As an example of the efficiency obtainable with the new highly efficient lamps, the author presents the curve shown in Fig. 2. It will be seen that in the case of the older types of lamps, the candle-power would have fallen rapidly, and the life would hardly have exceeded 100 hours at a consumption of 0·85 watts per H.K.; but, with the *new* lamps, a life of over 1,200 hours is secured, and

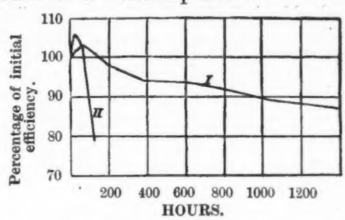


Fig. 2.—Comparative life tests of new and old type lamps.

Curve I. = New type.
Curve II. = Old type.

the candle-power only falls by about 10 per cent during the first 1,000 hours. It is also stated that the light from these lamps is distinctly whiter in tint, and that during the 1,000 hours there is now no appreciable blackening of the bulb. Tests have also been recently conducted by the Reichsanstalt, and the results in this case appear to have been equally favourable, the diminution in light during 1,000 hours, and at the same efficiency, being returned as only 8 per cent.

"Two-Colour Vision."

We are accustomed to speak of colour-blind people as being able to perceive two, three, four or more colours, as the case may be, and it has sometimes been assumed that all people of the dichromatic class see alike. This, however, according to Dr. Edridge-Green, is not so.* Much depends on the state of the eye. Moreover, in addition to incapacity to distinguish colours properly, there may be a second defect, namely, shortening of the spectrum at one end or the other. For example, a person may have apparently normal vision as regards naming and distinguishing colours, but on examination may prove to be unable to see certain rays in the extreme red. Throughout the rest of the spectrum his vision may be normal. On the other hand, the inability to perceive colours does not necessarily mean that the observer is insensitive to light. The combination of these two distinct effects gives rise to a great variety in vision of the so-called dichromatic class.

According to Dr. Edridge-Green's theory the eyes of such people show arrested development. It has been suggested that at one time in the past every one could see only one colour, so that the spectrum would appear drab grey throughout. Subsequently the red would appear at one end of the spectrum and violet at the other, and the region occupied by these colours would gradually extend as development progressed. Eventually other intermediate colours would make their appearance until we arrive at the state of colour-vision prevailing to-day.

Two interesting instances of dichromatic vision are mentioned. One of these relates to a man who was colour blind in one eye and not in the other. He was therefore able to compare his sensations, and described the spectrum seen through the colour-blind eye as being almost entirely grey, with a slight mixture of red at one end and violet at the other. The experience of a lady who lost her sense of colour and then gradually regained it was exactly similar. Dr. Edridge-Green remarks that in a third case, that of Dr. Pole, Maxwell regarded him as red blind, while Holmegren, as a result of wool tests, pronounced him to be green blind. Yet Dr. Pole apparently belonged to the same dichromatic class as the two cases cited above.

In his concluding remarks Dr. Edridge-Green points out that acuteness of colour perception differs to some extent among so-called normal people, and according to their state of health. One also meets some people who can distinguish colours in the case of strongly illuminated large surfaces, but cannot do so when the area lighted is small and feebly lit. Many such subsidiary effects have to be borne in mind in the study of colour blindness.

* 'Dichromatisches Sehen,' *Archiv. für die ges. Physiologie*, Bd. 145.

Short Notes on Illuminating Engineering.

From all Sources.

Long Overhead Gas Pipe.

An overhead gas pipe 2 kilometres (about $1\frac{1}{4}$ miles) long is a curiosity; such a line is to be seen, however, in Upper Schlesien, where there is a large central station distributing gas to various points in the not exactly immediate neighbourhood.

Formerly, except in the case of crossing streams and the like, gas lines were always laid underground for safety, as well as to prevent stratification. This method has, however, the disadvantage that permission must usually be obtained to dig up streets, &c., or cross fields. This has often led to the necessity of "cutting across lots" through a marshy or periodically overflowed region, unsuited for traffic or agriculture; but there, again, came the difficulty that the pipe often sank, and in any case was frequently for months difficult to get at on account of the water.

For these reasons the line in question is supported on piles about 80 in. above the earth surface. The line consists of welded wrought-iron pipe in sections of ten or twelve. The individual lengths are connected by flange joints, the sections being connected by expansion stuffing-boxes, the variation in length between summer and winter temperatures is very considerable.

The engineers who laid this line took advantage of freezing weather, in the same manner as in old days in the Siege of Antwerp; they waited until the marsh was frozen solid, and then carried the pipes and heavy wooden piles over the ice. This would have taken more time and cost much more if it had been done in summer.

An Indirect Gas Lighting Unit.

It will be recalled that some time ago we described an installation of indirect gas lighting in the offices of the Indianapolis Gas Company, U.S.A. The accompanying illustration shows a four-light unit, such as is used in the general

Fig. 1.—Four-light indirect gas lighting unit.

office of the above Company. Ordinary upright burners and mantles are used, surrounded by silvered glass reflectors. Each burner has its pilot flame, and the whole unit is controlled by a chain-pull.

The Best Miner's Safety Lamp.

A competition for the best electric safety lamp for miners was instituted in May last by the Home Secretary, a colliery proprietor having placed at his disposal 1,000*l*. for prize money.

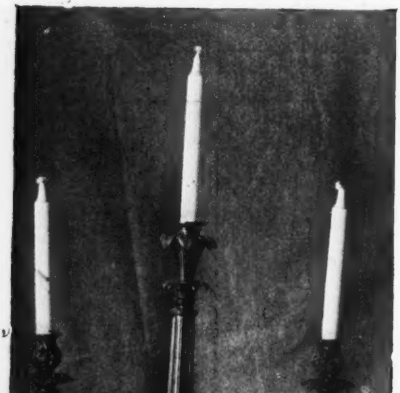
The winner of the first prize is now announced to be Mr. F. Farber, of Dortmund, Germany, the remaining eight prizes — of 50*l*. each — being secured, with one exception, by British firms.

Bay-Berry Candles.

The making of candles from the wax of the bay-berry was quite a common occupation for the housewives of olden times, and it appears that there is some tendency to revive the art in the United States.

A correspondent has sent us some interesting particulars as to how these candles are prepared.

The bay-berry, which grows wild in almost any district where there is hilly rock-pasture, is a blueish-grey berry,



found on a low bush clinging closely to the stem, just beneath the top cluster of leaves. About a quart of berries is required to make one candle, so a considerable amount of time must be devoted to the picking.

The boiling process which is necessary to get the wax from the berries follows the gathering, and occupies at least four hours. Two quarts of water are added to each quart of berries, and the whole allowed to boil steadily. After this the pot is left to simmer for an hour or two, and finally put to stand for the night, so that the wax may collect at the top. In the morning a cake of green wax is formed on the surface of the water, and can be lifted out ready for the moulding. It is often necessary to strain out fragments of stem, dirt, &c., which would otherwise spoil the candle. This can easily be done with a fine wire sieve, finishing off through a piece of cheesecloth.

All that is then necessary to complete the candle is to pour the wax—which must be slowly melted—into a mould, which may be of the old-fashioned sort made for the purpose or a home-made one of rolled-up paper. In either case care has to be taken to keep the wick accurately in the centre.

The finished candle is of a delicate green colour, and gives out a pleasant aroma when burning. Our illustration shows some old candlesticks containing bay-berry candles in a house at Salem, Massachusetts.

A Mythological Derivation.

Amongst the many people who use or know about the "Mazda" lamp there must be a few, at least, who have wondered what the word signifies and whence it is derived.

We are informed that the word comes from the Persian mythology surrounding the religion of Zoroaster—the worship of the sun, the God of Light. Briefly, the story is this: the ancient Magii of the East held that human affairs were ruled by two deities, or principles. One is Ahuru Mazda, the author of all good, eternally absorbed in light; the other, Angro Mainyush, the origin of all evil, dwelling in perpetual darkness. These two powers are engaged in a long and terrible conflict, and the prize of the victor is to be the collective soul of man. Mazda created man free, so that if he allows himself to fall under the sway of the swart and malevolent Angro he may justly be punished.

According to this mythology, Mazda must triumph ultimately, and there will then be one undivided kingdom of *light* in heaven and earth.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Indirect Lighting in Theatres.

Glare is just as much to be deprecated in theatre lighting as it is in the house or office. Indeed, it is possibly more harmful in the first case, because during the course of a play the auditorium of a theatre is plunged in darkness, and the eyes are apt to resent the sudden contrast of the dazzling lights which spring into being at the commencement of each entr'acte.

A method of lighting theatre auditoriums which is being widely adopted in America is the "Eye-Rest" system of indirect lighting, which is being developed in this country by the **British Thomson-Houston Co., Ltd.** In this system the lamps are entirely hidden from view by means of a metal or plaster bowl containing powerful upturned reflectors.

The accompanying illustration shows a portion of a theatre auditorium so lighted. As may be seen, the fittings harmonize well with the wall and ceiling decoration.

Gold Medal awarded Messrs. Ehrich & Grätz.

An unusual honour has been done to the firm of **Messrs. Ehrich & Grätz** of Berlin, who have received the gold "staatsmedaille" for industrial enterprise. This firm has been the recipient of the corresponding silver medal since 1904, and can look back on nearly fifty years of industrial activity. It was one of the first to recognize and develope the inverted mantle, and is still doing much to popularize modern incandescent gas lamps of this type.

Messrs. The Allen-Liverside Portable Acetylene Co., Ltd., have been awarded the certificate of the Institute of Hygiene for their acetylene table lamps.

Five Candle-Power Wotan Lamps

Messrs. Siemens Bros.' Dynamo Works, Ltd., inform us that they are actually placing on the market an entirely new grade of WOTAN lamp consuming only 7 watts, and giving 5 candle-power, which will be supplied in voltages from 90-130. The price is 2*s*. 6*d*. in the standard bulbs, 3*d*. extra in the round type.

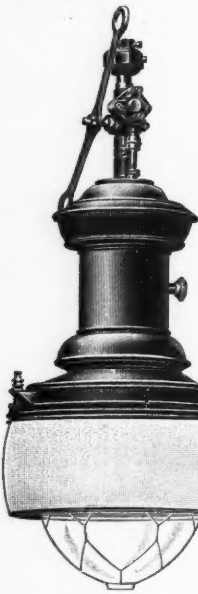
The feature of this lamp is the extraordinary fineness of the filament, many times thinner than a human hair, which the mechanical strength of the drawn wire renders practicable.

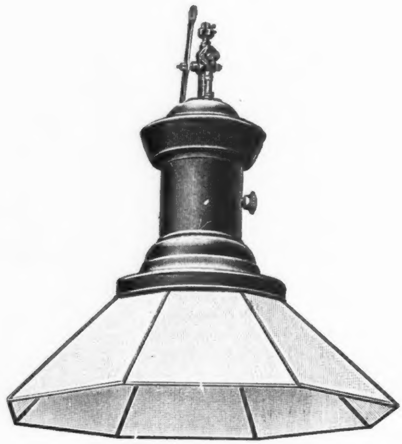
We have received from **The British Westinghouse Electric & Manufacturing Co., Ltd.** (Trafford Park, Manchester), some leaflets from their catalogue dealing with Ammeters, Voltmeters, and Leakage Detectors.

Messrs. Baxendale & Co., Ltd. (Miller Street Works, Manchester), draw attention to their "Thikflex" lampholders, referred to in their list of Electric Light Supplies, a copy of which they have sent us. They claim for this holder (of which we have a sample) that it is especially easy to wire, has perfect insulation, and a very strong cord grip.

New Shades for High-Pressure Keith Lamps.

Two new types of shade have recently been developed by **Messrs. James Keith & Blackman Co., Ltd.** (27, Farringdon Avenue, London, E.C.), for use with their high-pressure inverted incandescent gas lamps. The first of these, which we illustrate herewith, consists of an opal screen surrounding the upper part of the ordinary clear-glass shade. This serves to protect the eyes from the glare of the bare mantle, and at the same time allows an upward diffusion of the light, though not in any way obstructing the path of the downward rays.





The other shade, designed for inside use, is also of opal glass, but of conical shape, and it takes the place of the ordinary enamelled reflector. No globe is required with this reflector.

The Applications of Arc Lighting.

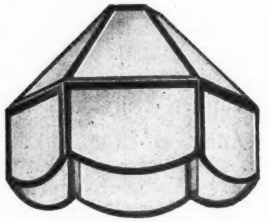
Messrs. Union Electric Co. (Park Street, Southwark, London, S.E.) have got out a very elegant series of well-written and beautifully illustrated booklets describing the application of arc lighting to factories, shops, &c., and giving details of their "Excello" and "Kohinoor" lamps. We have before us a copy of the pamphlet dealing with the Artificial Lighting of Low-roofed Factories. This is illustrated by a series of excellent photographs, which will probably serve even better than the text to emphasize the value of arc lighting, especially on the indirect system, for buildings in which good light and hygienic conditions are of paramount importance.

A Small Capacity Time Switch.

Messrs. William Geipel & Co. (Vulcan Works, St. Thomas Street, London, S.E.) have sent us a leaflet describing a new model of their automatic Time Switch, which they have recently brought out. It will be recalled that we have previously referred to the 30-ampere model. The new switch is designed for a much smaller current capacity—5 amperes—and is suitable for use in interior lighting, staircases, corridors, &c., where the number of lamps to be controlled is not large. A quick make-and-break action is obtained by means of a spring, which is gradually wound up as the dial revolves, and then automatically put in tension at the moment of switching on or off.

Catalogues Received.

Messrs. Siemens Bros.' Dynamo Works, Ltd. (Tyssen Street, Dalston, London, N.E.), have sent us their latest list, No. D5, dealing with Shades and Reflectors of Glass, Metal, and Silk. We note among the new features of this list a selection of bead and lustre shades, which, it is suggested, are particularly effective on massive fittings. A variety of silvered glass and mirror reflectors for shop-window lighting are illustrated on pp. 22–24, and the list concludes with a number of artistic designs for silk shades.



Another list recently issued by Messrs. Siemens Bros. gives particulars and prices of their 'Wotan' Battery Lamps. While these low-voltage lamps are intended primarily for use on motor-cars, they have many other uses, such as for hand-lamps, miners' lamps, and the lighting of yachts, &c.; in fact, any case in which lamps are run from small accumulators. The filaments are, of course, of drawn tungsten wire, thus securing great mechanical strength as well as long life for the battery on account of the small current consumption.

The Sun Electrical Co., Ltd (118–120, Charing Cross Road, London, W.C.), have sent us a comprehensive catalogue of Sign-Flashers. We note in this a new quick break form of the thermo-flasher, and also their latest design of mercury contact magnetic flasher. An illustration is given in the list of a sign in script letters, which is controlled by a motor flasher, giving the effect of writing the words.

Mazda Lamps in Music Halls.

Nowadays a music hall, if it is to retain its patronage, must be not merely adequately, but brilliantly lighted. The introduction of the metal filament lamp made it possible to do this without increasing the consumption of electricity. But the ordinary metal lamp with pressed filament was too fragile for use in battens and footlights, and consequently carbon lamps had to be retained in these positions.

The Mazda drawn wire lamp has now removed even this limitation, and Mazda lamps are used throughout some thousands of theatres in all parts of the world. A certain theatre has 400 40-watt Mazdas in use as stage border lights, footlights, and sidelights. The durability of these lamps was very seriously tested at a recent performance, when a weight-lifter indulged in the jolly pastime of lifting artillery wagons and cannon balls and dropping them on to the stage floor. Yet during the twenty-one performances of the strong man only two lamps, or one-half of 1 per cent of the total lamps installed, were broken.

A recent Mazda music-hall installation is that at the Alhambra Theatre in Leicester Square, London, in which Mazda lamps are employed throughout for stage and auditorium lighting. In addition to this famous music hall there are some fifty other theatres in the London area, including the Oxford and Tivoli, using Mazda lamps.

For the Convenience of Contractors.

It is a great convenience for the contractor to be able to purchase the whole of his stock from one firm. By doing this he avoids a multiplicity of small accounts, and economizes the time and labour of his book-keeping staff.

Recognizing that such a convenience has become almost a business necessity, the **British Thomson-Houston Co.** have recently widened the scope of their activities to include the supply of wiring accessories. The contractor can now buy everything electrical at Mazda House. The counters are sectionalized. At one counter Mazda lamps are sold, at another Gem and B.T.H. Edison carbon lamps, and at a third every sort and size of wiring accessories.

B.T.H. Wires and Cables.

Owing to recent increases in the cost of raw material the British Thomson-Houston Co. have had to make a 5 per cent advance in the prices of all their wires and cables. This advance takes effect from August 21st.

REVIEWS OF BOOKS.

The Art of Illumination. By Louis Bell. (McGraw-Hill Book Co., 239, West 39th Street, New York, and 6, Bouverie Street, London, E.C.; 1912 Revised Edition; 10*s.* 6*d.* net.)

DR. LOUIS BELL's well-known work on this subject was among the first books written in English on illumination. Since the issue of the first edition much has happened. The Illuminating Engineering Societies in the United States and Great Britain have been formed, and the movement for better lighting conditions has received recognition all over the world. The revision of the work has therefore added greatly to its value.

We notice that the information on electrical illuminants has been brought up to date by the inclusion of descriptions of such lamps as the quartz tube mercury vapour lamp, the Jandus arc, &c., and the chapter on shades and reflectors has been enlarged to include some of the latest picture-lighting and other special devices. The concluding portion of the book dealing with interior and exterior lighting is now most serviceable. We notice that there is constant reference to discussions of the London Illuminating Engineering Society, and Dr. Bell's recommendations on school and library lighting are similar to those being formulated in this country. On street lighting also Dr. Bell is an acknowledged authority, and he draws on his experience of the illumination of streets in both American and Continental cities with good effect. The initial chapter on light and the eye embodies much original work, and the two final chapters on spectacular lighting and "the illumination of the future" are most suggestive.

The book now contains about 350 pages. It only remains to add that it is written in Dr. Bell's characteristic lucid manner, and should appeal to a wide circle of readers.

L'Annuaire International de l'Acétylène, 1912 edition. By R. Granjon and Pierre Rosemberg. (Bibliothèque de l'Office Central de l'Acétylène, 104, Boulevard de Clichy, Paris, 3fr.)

THE 'Annuaire' for 1912, which occupies 360 closely printed and abundantly illustrated pages, again makes interesting reading. As usual, the book contains details of the chief varieties of generators, burners, heating and welding apparatus, &c. Some striking data relating to the progress of the industry in France are also given, including a diagram showing the substantial and regular advance in the consumption of carbide in France from 1897 to 1911. There seems little doubt that in France the organization of the industry has been carried to a fine art.

A particularly interesting chapter from our standpoint is that relating to special applications of acetylene. Illustrations are given of the use of dissolved acetylene for lighting buoys, railway signals, carriages, &c., and for cinematographic purposes. One is also struck by the extensive application of acetylene in France for the lighting of small towns.

Les Principaux Appareils à Acétylène. (Office Central de l'Acétylène, 0fr. 60.)

THIS is another smaller illustrated publication of the Office Central devoted to acetylene apparatus. Advice is given as to the points to be observed in arranging an installation, and the choice of a suitable generator. Following this is a classified description of the chief makes of apparatus in use in France.

Lehrbuch der Leuchtgasindustrie. By Dr. W. Bertelsmann. (Ferdinand Enke, Stuttgart, 1911, mk. 20.)

THIS work is issued in two volumes. The first deals with the production of gas, the second with its applications. The two together contain over 1000 pages. In vol. i. the nature of coal and coke and its derived products, the generation, purification, and distribution of gas to consumers, and the methods of testing (including photometry) are described.

The second volume, which is of chief interest to us, is devoted to the use of gas. There is a brief introductory sketch of the historical development of gas lighting, followed by a short discussion on radiation and the physics of light production. Subsequently there is an exceptionally complete account of gas mantle manufacture. The methods of weaving the fabric, the comparative advantages of ramie and artificial silk and cotton are well treated, and the more purely scientific aspects of the radiation from the mantle discussed.

In further chapters the upright and inverted burner, high-pressure gas lamps, methods of central suspension on wires across streets, and automatic distance ignition are all fully dealt with. The author also includes a brief account of the laws of illumination and photometry, but the illumination photometers described are exclusively German. Tables for the calculation of illumination are also given. Gas heating and cooking is next treated, and the book concludes with a readable chapter on the development of the gas industry in Germany.

The work is evidently well up to date as regards German practice. The illustrations are clear and abundant, the only diagrams which do not seem quite satisfactory being the polar curves of light distribution; here the groundwork of radial lines and circles is omitted, and this makes it inconvenient to compare the various curves. The author has followed the practice of giving a list of references to the subject-matter at the end of each chapter. These references refer mainly to articles in the *Journal f. Gasbeleuchtung.*

Practical Exercises in Physiological Optics. By Prof. G. J. Burch, M.D., D.Sc., F.R.S. (Clarendon Press, Oxford, 4*s*. net.)

THIS little book was written for the practical classes in Physiological Optics at Oxford University, and contains a number of suggestive experiments, some of which will doubtless be new to many of those interested in this subject.

There are six sections containing upwards of sixty problems. Section I., on dioptrics, contains more or less familiar work on lens-formulæ and their application to the eye, and Section II. is devoted to more advanced exercises on the same subject. Section III. deals with judgment of space and distance, and Section IV. is headed "the sensations of the eye." These experiments will be interesting to many of those who have studied the physiological basis of photometry—the last four on the exhibition of the yellow spot, blind spot, Weber's law, and Purkinje's phenomenon perhaps especially so. The same applies to the measurement of colour sensations (Section V.). The remaining section deals with experiments on flashing lights.

Many of these experiments touch on points which have been the subject of much controversy in the past. Some require the use of darkened rooms and most careful observation of the prescribed conditions. A student who has been through this course should realize to the full the extreme complexity and powers of adaptation of the eye.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

THE articles in this section may this month be divided into three groups.

There are, firstly, a series of original articles on photometry ; secondly, various general contributions on the progress of illuminating engineering ; and, thirdly, certain articles dealing with specific lighting problems and installations.

In the first group we may notice an article by SHARP and MILLAR (*Elec. World*, Aug. 3) on **A New Form of Illumination Photometer** This is very compact in form, and utilizes a method of regulating the voltage by comparing a carbon and metallic filament lamp with one another. The instrument also uses a specially shaped adjustable shutter to vary the light.

Next may be noted PFUND's contribution on the use of **Selenium Cells** (*Phys. Review*, May). He discusses their various irregularities, perhaps the most interesting point being the progressive change in colour-sensitiveness of such cells (analogous to the Purkinje effect) with rising illumination. IVES also describes a novel device in photometry, namely, the use of sensitive paper to obtain polar curves of distribution of light. The paper is bent round the source in the form of a cylinder of large radius, and, after exposure, developed under such conditions that the darkening at each point is proportional to the corresponding intensity. The method is mainly useful for fluctuating and unsteady sources.

Among other communications of a more general scope we may note PIERCE's popular explanation of polar curves and mean spherical candle-power, and the account by WEISS and OTT of the laboratory of the Zürich Gas Works (*J.f.G.*, Aug. 5).

Turning to articles in the second group, we note in *The Electrical World* (Aug. 5) a reference to MR. GASTER's address before the American Illuminating Engineering Society, urging the desirability of co-operation between this and the British Society. In *Licht und Lampe* there is an article on the 'Aims of Illuminating Engineering' (July 18). Here it is contended that light should obtain attention from the sanitary authorities in the same way as ventilation and fresh air, &c. KRUH (*Elek. u. Masch.*, July 28, Aug. 4) contributes a readable article on **Chemistry of Illumination.** He points out the part played by the chemical properties of substances used in arc and vapour lamps, and gives an account of some of the complicated chemical processes to which incandescent lamp filaments have to be subjected.

Finally, there are several articles dealing with specific lighting problems. CROUCH (*Elec. Rev.*, July 19) discusses **American Practice in Lamp-posts,** giving line illustrations of a number of well-known types in cities in the United States. He contends that many of these are distinctly superior to European types, and points out the convenience of subdividing the light into several units on the same post. HADLEY (*Elec. World*, July 13) describes the **Lighting of the St. Louis Public Library.** One interesting feature is the combination of indirect general illumination with local table-lights.

ELECTRIC LIGHTING.

L. BLOCH (*E.T.Z.*, Aug. 1) analyzes the conditions governing the **Most Efficient use of Incandescent Lamps.** He comes to the conclusion that metal filament lamps should be renewed when they have lost 25 per cent of their initial candle-power. An editorial in *The Electrical Review* (N.Y.) discusses the **Fragility of Tungsten Filaments.** It is pointed out that both the squirted and drawn filaments tend to become crystalline, and therefore more or less brittle in course of time ; but the initial crystalline nuclei in the drawn filament are not so large, and therefore the process is slower.

B. MONASCH (*E.T.Z.*, July 18) compares the light from **Electric Incandescent and Petroleum Lamps.** He gives the polar curves of both lamps with various forms of reflectors, and argues that the only right method of comparison is in terms of a certain illumination over a

given horizontal area, and not the horizontal candle-power in the two cases.

BRENCKLÉ (*J.f.G.*, July 13) describes a new apparatus intended to avoid the loss in series resistances used with an arc lamp on a D.C. circuit. The device involves an elaborate combination of special "polarisation cells" and special resistances made of iron wire mounted in hydrogen.

H. E. IVES (*Elec. World*, Aug. 10) writes on combinations of lamps with the **Mercury Arc to Produce White Light.** He points out that the result of the rhodamine reflector is to give a light which, to the eye, appears somewhat bluish; it could be made to resemble daylight more closely by some fluorescent material which added yellowish rays in addition.

GAS, OIL, ACETYLENE LIGHTING.

One of the most interesting articles on gas lighting is that by A. M. CLELAND (*G.W.*, July 13; *J.G.L.*, July 16), who discusses the advances made by **High-Pressure** lighting in Belfast, and gives particulars of the lights required for various trades (laundries, confectionery, &c.). He gives the cost of high-pressure gas (60 c.-p. per cub. ft.) as 0·36*d.* per 1,000 c.-p. hours, and low-pressure (30 c.-p. per cub. ft.) as 0·7*d.*, with gas at 1*s.* 9½*d.* per 1,000 cub. ft. He also enters into a discussion of the relative merits of upright and inverted burners, a matter which is also treated by Fitzpatrick (*J.G.L.*, July 23).

S. B. CHANDLER also deals with high-pressure gas lighting, going into the theory of the kind of flame required and the merits of single, double, and triply woven mantles. He refers to the value of parabolic reflectors outside shops, and gives the curve of distribution of light obtained therewith (*J.G.L.*, Aug. 6).

SNELLING (*Prog. Age*, Aug. 1) contributes a readable article summarizing the chief advantages of various kinds of **Liquid Gas**; and KLEBERT (*J.f.G.*, July 13) completes his serial article on modern methods of **Illumination for Lighthouses, Buoys,** &c. In this instalment he deals mainly with flashing lights, giving data regarding the candle-power of the various lamps, and referring to uses of oil gas blau gas, and dissolved acetylene, especially in connexion with automatic intermittent flashing buoys.

In the *Rev. des Éclairages* there are several articles on acetylene lighting. Much attention is devoted to the new "tax on light" which is said to be in contemplation in France. Interesting data are also given as to the lighting by acetylene of small towns. This method of illumination is regarded as suitable for towns of 1,000–4,000 inhabitants, and in France there are already 175 so lighted.

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Clewell, C. E. Industrial Illumination (*Elec. World*, July 6).
Crouch, L. Notes on Design of American Street Lighting Standards (*Elec. Rev.*, July 19).
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Sharp, C. H., and Millar, P. S. A Simplified Illuminometer (*Elec. World*, Aug. 3).
Weiss, A., and Ott, E. Das neue Lichtmess-Laboratorium des Gaswerks Zürich (*J.f.G.*, July 27).
Co-operation between Illuminating Engineering Societies in United States and Great Britain (*Elec. World*, Aug. 10).
Ziele und Zukunft der Beleuchtungstechnik (*Licht u. Lampe*, July 18).

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Brencklé. Elektrisches Gratislicht (*J.f.G.*, July 13).
Byrne, W. S. Possibilities of the Electric Sign (*Elec. Rev.*, N.Y., July 20).
Cramb, A. C. Electricity *v.* Gas for Church Lighting (*Elec. Times*, Aug. 15).

Editorial. The Fragility of Metal Filaments (*Elec. Rev.*, Aug. 3).
The Mercury Arc Lamp in Practice (*Elec. World*, July 27).
Three Phase Flame Arclamps (*Elec. World*, Aug. 3).
Ives, H. E. A Study of the Light from the Mercury Arc (*Elec. World*, Aug. 10).
Monasch, B. Elektrische und Petroleum Beleuchtung (*E.T.Z.*, July 18).
Othmer. Zeichensaal-, Bureau und Schul-Beleuchtung (*Licht u. Lampe*, July 15).
Miller, W. H. French and German Quartz Tube Mercury Vapour Lamps (*Elec. World*, July 27).
Wilson, H. G. Outdoor Wiring for Incandescent Lamps (*Elec. Rev.*, July 13).
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GAS, OIL, AND ACETYLENE LIGHTING.

Albrecht and Wolfmann. Gas und Elektricität (*J.f.G.*, July 20).
Chandler, S. B. Gas Lighting under Pressure (*J.G.L.*, Aug. 6 ; *Co-partnership Journal*, August).
Cleland, A. M. Notes on High Pressure Lighting (*G. W.*, July 13 ; *J.G.L.*, July 16).
Fitzpatrick, P. J. Upright *v.* Inverted Incandescent Burners (*J.G.L.*, July 23).
Klebert, E. Mitteilungen über moderne Leuchtfeuer und Leuchtbojen (*J.f.G.*, July 13).
Snelling, W. O. Illuminating Gas in Liquid Form (*Prog. Age*, Aug. 1).
A Mercury Vapour High Pressure Lamp (*G.W.*, Aug. 10).
Neuere Invertbrenner (*Z.f.B.*, Aug. 10).
The Nonpareil Ventilating Gas Sun-Burner (*J.G.L.*, July 23).
Interchangeability of Street Lantern Parts (*J.G.L.*, Aug. 6).
L'Impot sur la Lumière (*Rev. des Eclairages*, July 15, 31).
L'Acétylene au Pantheon (*Rev. des Eclairages*, July 31).
L'Éclairage des Villes en France (*Rev. des Eclairages*, Aug. 15).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. u. Masch.—Elektrotechnik und Maschinenbau.
G. W.—*Gas World.*
J. f. G.—*Journal für Gasbeleuchtung.*
J. G. L.—*Journal of Gaslighting.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

Some Publications Received.

Lectures delivered at the Centenary Celebration of the First Commercial Gas Company (edited and published by the American Gas Institute).

Atti del Congresso Internazionale delle Applicazioni Elettriche (Turin, Sept. 10–17, 1911), Vol. II.

Journal of the Municipal School of Technology, Manchester, Vol. V. (A record of Investigations undertaken by members of the teaching staff and students of the school.)

The Textile Institute Journal (No. 1, Vol. III.).

Ultra-violet Radiation from Ordinary Illuminants. By M. Luckiesh. (Reprinted from *The Electrical World*, June 15, 1912.)

An Analysis of Glare from Paper. By M. Luckiesh. (Reprinted from *Electrical Review and Western Electrician*, June 1, 1912.)

Photometerkurven und Logarithmenpapier. By N. A. Halbertsma. (Sonderabdruck aus *Archiv. f. Elektrotechnik.*)

Lamp Efficiency. (Pamphlet issued by the Engineering Dept. of the National Electric Lamp Association : Bulletin 101.)

Wie ein Fabrik-Unternehmen die industrielle Hygiene fördert. By Dr. W. H. Tolman. (Paper read at the International Congress for the Prevention of Industrial Accidents in Milan, 1912.)

10

The ILLUMINATING ENGINEER

· ELECTRICITY · ACETYLENE · OIL · GAS ·

Edited by LEON GASTER

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EDITORIAL.

Illuminating Engineering Progress in the United States.

THE Illuminating Engineering Society in the United States was started a few years before the corresponding society in this country, and the movement has proceeded there on somewhat different lines. In many respects it is more advanced. But in others, local circumstances have enabled the British Society to make exceptional progress. The writer, in the course of his mission of bringing about a closer co-operation between these Societies, had recently an opportunity of studying the development of the movement in the United States. Before presenting his official Report to the Council he would like to take this occasion of expressing his appreciation of the invariable kindness and attention shown in the course of his visit during the last two months.

At a special meeting called by the New York section of the Illuminating Engineering Society on August 1st, the writer gave an account of the progress made in this country, and various well-known authorities on illumination spoke, and expressed their cordial desire for closer relations between the two societies.

Great appreciation was expressed of the remarkable advance of the illuminating engineering movement in England during such a short time. The direct interest taken by the Home Office in the lighting of factories, and the support given by educational authorities to special courses of lectures on illuminating engineering, were considered most encouraging signs. In the United States the question of standardization of factory lighting cannot be so easily arranged because there are many different States, each having its own legislation. Nevertheless, one may expect that recognition of our efforts will come from the more

progressive States, and will in time be copied by others, so that the proper treatment of illumination should become quite general.

In the manufacture of incandescent electric lamps the United States has doubtless been helped by the splendid system of organization and co-ordination of interests of the National Quality Lamp division of the General Electric Co. The understanding existing between supply companies and manufacturers has been a great gain to the electrical industry. In the United States one does not see the extraordinary diversity of aim between manufacturers and electric lighting companies that occurs over here. Now, in the United States the tendency has been to encourage better illumination rather than smaller expenditure. Consequently, the consumer, the lamp manufacturer, and the supply company all share in the benefit derived from the new lamps.

Electric lighting is making great strides in America. Except for a few towns the development of gas lighting has been less rapid. There is undoubtedly a demand for improvement, but the industry has not yet risen to the occasion. High pressure lighting, which has done so much for street lighting in Europe, is as yet in its infancy in the United States. A compliment has been paid to the British Illuminating Engineering Society in the invitation issued to its Chairman of Council, Mr. F. W. Goodenough, to present a paper on High Pressure Gas Lighting at the coming Convention. We have no doubt that he will have much to tell our friends in America regarding the recent developments in London.

The design of globes, shades, and reflectors, and their incorporation with the lamps as one unit, has reached a more advanced stage. The idea that proper methods of shading are essential for good illumination has caught on very thoroughly. There are, however, still unfulfilled possibilities of progress in this direction.

The great companies in the United States interested in lamps and lighting show great keenness in studying the wants of the consumer. They have almost without exception organized illuminating engineering departments, and have brought publicity arrangements to a fine art. The value as a commercial asset of literature which is not merely obvious advertisement, but contains genuinely interesting and informative matter is fully appreciated. This spirit has been fostered by the Illuminating Engineering Society, which is now issuing a primer on illumination. This is to be circulated broadcast. No doubt in course of time publications on illumination in this country will be more widespread and popular in character, and co-operation between the Societies will be desirable in order to secure some degree of uniformity in nomenclature and general methods. When the use of the terms now habitually employed in illuminating engineering was restricted to a few experts, divergencies in methods of expression did not so much matter. Now that the movement is becoming more general in scope, it is well to proceed on similar lines as far as possible, and to make arrangements for taking common action all over the world. The international scope and widespread influence of our Society should be most beneficial in bringing about this needful co-operation on all matters relating to illumination.

Illuminating Engineering Laboratories.

Another sign of the growth of the illuminating engineering movement in the United States is the organization of laboratories dealing with various aspects of illumination. For many years most valuable work has been done at the Bureau of Standards in connexion with standards of light.

A considerable amount of industrial photometry is done at the Electrical Testing Laboratories of New York under

Dr. Sharp and Mr. P. S. Millar, and there are other technical laboratories, organized by the various companies, in which research work on lamps and illuminating apparatus is constantly going on. The advantage possessed by a large company, as compared with a number of small concerns, is here very evident. With its greater resources it can organize and maintain a single well-equipped laboratory and secure the services of the very best men, and at a much smaller figure than would be needed to maintain a number of separate institutions. An instance is afforded by the laboratory of the General Electric Co. at Schenectady, where valuable researches on electric lamps are being constantly carried out under the supervision of Dr. Whitney. The United Gas Improvement Co. of Philadelphia have recently appointed Dr. H. E. Ives to undertake the supervision of their research laboratory.

There can be no question of the soundness of the policy of encouraging such researches. But the degree of usefulness of such laboratories depends on there being a clear and definite idea as to the aims and objects to be pursued, and a recognition of what can be done with the means available.

A technical laboratory equipped by a lamp manufacturing concern should interest itself primarily with researches in improvements in lamps and methods of manufacture. But a company which takes a wide view of the importance of good illumination should encourage the laboratory to attempt the solution of general problems in illuminating engineering, and to work hand in hand with the publicity department while doing so.

The writer has on several occasions drawn attention to the splendid example set by the National Electric Lamp Association (now the National Quality Lamp Division of the General Electric Company), which organized an excellently equipped laboratory at Cleveland under the supervision of Dr. Hyde. Now several years have elapsed since this laboratory was founded, and the world would naturally like to hear more of the researches undertaken and results obtained there. Such a well-staffed and expensively equipped institution should publish its results at frequent intervals. From the scientific standpoint this is desirable, so that any possible overlapping with the work of other institutions can be avoided; and it would also be well for the methods employed to be clearly stated, so to enable an accurate comparison with other researches to be made. We are familiar with Dr. Hyde's valuable researches on physical problems, some of which have been already published, but it would be instructive to have an account of the more practical experiments carried out and the methods adopted for making them generally known. We understand that new and still more completely equipped premises are in course of erection. The work of the laboratory ought therefore to secure the widest publicity in order to justify the generous support of the most progressive lamp concern in the States, and the most enthusiastic supporters of the advancement of good illumination.

The Congress of the Textile Institute

At the Congress of the Textile Institute held last month in Hawick there were many interesting events, but we should like to single out for special reference the series of papers read on the driving of machinery by steam, gas, oil, and electricity. A Committee is to be appointed to go further into this subject, and the information in these papers will doubtless form a useful guide to its subsequent deliberations. The idea of inviting several representatives to read papers simultaneously on their respective systems was a good one. This method has been adopted and proved beneficial at some of the meetings of the Illuminating Engineering Society, dealing with the merits of rival illuminants for specific purposes.

The question of driving textile machinery is now at an interesting stage. Revolutionary improvements have been made, and, with most methods, great economies effected. But we venture to suggest that the *lighting* of such machinery is equally important, and we have reason to believe that the Textile Institute will take this up in the same thorough manner. Care spent on the illumination of complicated machinery is well repaid. Plant in an ill-lighted shop invariably gets into poor condition and the quality of the work suffers. The same applies to the "human machinery." It is of no use to expect first-class results when the illumination is deficient, and the workers cannot see what they are doing; bad lighting is a frequent cause of spoilt work and accidents. It is not only a question of sufficiency of light. The method of arranging the lamps so as to secure proper distribution of light, absence of harmful shadows, and avoidance of glare is equally important. In addition there are many special problems, such as the correct appearance of coloured objects and the production of artificial daylight for colour matching, which are vital in many sections of the textile industry. At a future Congress some account of the methods now adopted with a view to getting correct colour values by artificial light would doubtless prove of considerable interest.

The Light from Oil Lamps and Barometric Pressure.

The contribution by M. Guiselin in this number shows that the difficulties inherent in the exact photometry of flame standards are making themselves felt in connexion with oil lamps. The variation of the pentane and other flame standards with barometric pressure and atmospheric moisture are well known both to the electrical and the gas industry, and such phenomena are always in evidence when the photometry of luminous flames is undertaken.

According to M. Guiselin's tests, which were all carried out with a Luchaire petroleum standard lamp, quite appreciable errors may be introduced in the comparison of varieties of illuminating petroleum by the usual barometric fluctuations. The effect of water-vapour does not seem to have been studied as yet, and possibly the inclusion of this factor will lead to considerable modification in the results. It will be interesting to have further confirmation of M. Guiselin's results from other observers. The importance of attention to detail, in order to obtain the most efficient results from illuminating petroleum, is well known, and promising methods of obtaining improved conditions by careful design of lamps, wick burner, chimney, &c., are well worth investigation.

Lectures on Illuminating Engineering.

We should like to direct readers attention to the announcement, on p. 489 in this number, of the special course of lectures on illuminating engineering shortly to commence at The Polytechnic (Regent Street, London).

One of the most striking signs of recent progress has been the constant demand for information on lighting. There are now quite a number of publications dealing specifically with the subject, and many firms organize special lectures and demonstrations for the benefit of their employees. We look to see illumination taking a more prominent position in the syllabus of colleges and institutions in the future. Meantime we hope that the coming course will again receive widespread support and prove as successful as last year. The lecturers, it may be mentioned, are all members of our Society. This steady educational movement that is now taking place should bear good fruit in time to come, and will ultimately prove of immense benefit to the lighting industry.

LEON GASTER.

Review of Contents of this Issue.

THE first article, by M. GUISELIN (p. 453), describes a series of **Tests on Oil Lamps.** The essential point brought out by these investigations is that the light yielded by a petroleum lamp depends to a great extent on the barometric pressure; consequently, the results obtained, when comparing various qualities of oil, differ with varying climatic conditions. Water-vapour may also have an effect, but this has not yet been investigated.

Following this will be found a list of the papers read at the Convention of the Illuminating Engineering Society in the United States. It is expected that some of these papers will be dealt with in our next number.

An account is next given of the method of **Lighting in the Whitehall Club** (p. 459), where tungsten lamps and Holophane reflectors are largely employed. Data obtained in the dining-room, smoking-room, card-room, and billiard-room are given. Chandeliers carrying six lights are employed down the centre of the room in most cases. The lighting of the billiard tables merits special attention, a very uniform illumination of 16–20 foot-candles being obtained with only six lights to the table.

Pages 465–8 are devoted to an account of the **Moore White Light,** and some particulars are given of the first installation of this kind set up in London. The light is claimed to be very closely similar to daylight in colour, and to provide a trustworthy substitute. The installation referred to is used by a firm of hop merchants. In this industry exact colour-discrimination of the material is important, in order to judge its grade. Three-phase installations are found to be best in circumstances where moving objects have to be illuminated, so as to avoid any inconvenient "stroboscopic" effects. Among other industries in which exact colour-matching is essential may be mentioned textile and dyeing works, carpet and ribbon manufactures, the grading of tobacco and coffee, &c.

Following this is an account of the **Quartz Tube Mercury-Vapour Lamp.** The explanation of the high efficiency of this lamp is given, and it is pointed out—by means of diagrams—how the electrical regulation of the lamp is accomplished. Finally, a polar curve showing the distribution of light from the tube is given. At the conclusion of this article we give a summary of the chief qualities of a new form of **Mercury Vapour Lamp, in combination with a Tungsten Lamp,** so as to produce white light. The mercury tube is bent into a ring, and the tungsten lamp is placed at the centre. Around both is placed a diffusing bowl, which serves to mix the colours and produces an apparently white light. The lamp is very compact in form, and a novel feature is the method of starting. This is accomplished by a mercury break inside two small subsidiary vessels. The mercury surfaces are separated by an electromagnetic device, and this sudden interruption of a highly inductive circuit raises the voltage across the tube, and renders it temporarily conducting, enabling the lamp to start. The consumption of the new lamp is given as 0·73 watts per mean hem. sph. candle-power.

An account is also given of a new form of lamp with mercury-cadmium electrodes. It is stated that by this means the missing red element in the spectrum of mercury can be provided and an approximately white light obtained. As the electrodes are solid, special devices have to be employed for starting the lamp.

At the conclusion of the number will be found the usual **Trade Notes** and the **Review of the Technical Press.**

Illuminating Engineering Society, Niagara Falls, Hotel Clifton, Ont.

September 16th to 19th, 1912.

PROGRAMME.

1. Addresses of Welcome, by Mr. O. E. Dores, President of Board of Trade, Niagara Falls, Ont., and Mr. G. F. Nye, President of Board of Trade, Niagara Falls, N.Y.

2. Response to Address of Welcome.

3. Presidential Address, by Mr. V. R. Lansingh.

4. Report of Committee on Progress. This report will deal with the recent progress and developments in the lighting industry both in this country and abroad.

5. A Report of the Committee on Nomenclature and Standards, which will deal with certain definitions and terminology of illuminating engineering.

6. 'Steel Mill Lighting'—a report of the Committee on Illumination of the Association of Iron and Steel Electrical Engineers—to be presented by the Chairman, Mr. C. J. Mundo.

7. 'High Pressure Gas Lighting,' by Mr. F. W. Goodenough, Chairman of Council, Illuminating Engineering Society, London, Eng.

8. 'The Status of High Pressure Gas Lighting,' by Mr. George S. Barrows. This paper will be a collation of domestic and foreign correspondence pertaining to high-pressure gas lighting.

9. 'Recent Developments in Gas Lighting,' by Mr. R. F. Pierce

10. 'Indirect and Semi-Indirect Illumination,' by Mr. T. W. Rolph.

11. 'Recent Developments in Series Street Lighting' by Dr. C P. Steinmetz.

12. 'Research Methods,' by Dr. E. P. Hyde.

13. 'The Problem of Heterochromatic Photometry and a Rational Standard of Light,' by Dr. H. E. Ives.

14. 'Reflection from Coloured Surfaces,' by Mr. Claude W. Jordan.

15. 'Diffuse Reflection,' by Dr. P. G. Nutting.

16. 'A Study of Natural and Artificial Light Distribution in Interiors,' by Mr. M. Luckiesh.

17. 'The Physiology of Vision,' by Dr. T. A. Woodruff.

18. 'The Light of Small Stores,' by Messrs. Clarence L. Law and A. L. Powell.

19. 'The Efficiency of the Eye under Different Systems of Illumination,' by Dr. C. E. Ferree. This paper will be a report of a research carried on for the American Medical Association.

20. 'A Proposed Method of Determining the Diffusion of Translucent Media,' by Mr. E. L. Elliott.

21. 'The Determination of Illumination Efficiency,' by Mr. E. L. Elliott.

22. 'An Absolute Reflectometer,' by Dr. P. G. Nutting.

23. 'Colour Values of Illuminated Surfaces,' by Mr. Bassett Jones, Jun. This subject will be presented in the form of a series of experimental demonstrations.

24. One session will be arranged for a potpourri, at which discussions will be in order on miscellaneous phases of illuminating engineering. It is expected that this session will bring out interesting and valuable points not particularly covered by the above papers and reports.

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

Notes on the Quality of Petroleum for Illuminating Purposes.*

By A. Guiselin,

Secretary of the International Petroleum Commission.

I. Chemical Methods of determining the Illuminating Quality of Petroleum Oils.

As I have previously pointed out, and have no hesitation in repeating, the main essential quality of good petroleum is to burn well in lamps; but it is also necessary to know how such lamps should be used.

When petroleum was first employed for illuminating purposes, various types of lamps were constructed to burn American oil, which alone was available at that time. Since then the same methods have been invariably used in commerce, and have imposed themselves on the sale of petroleum throughout the world.

Some years ago I expressed the opinion, in connexion with Roumanian oil, that "there do not exist bad qualities of petroleum, but only bad lamps and people who do not use them properly." As a result of many subsequent experiments, I can confirm this declaration, always true for moderate qualities of burning oil; but would add to it the following corollary: "A *good* petroleum can be burned in all kinds of lamps."

The question arises whether it is possible to frame a specification for illuminating petroleum such as was suggested at the second Session of the International Commission in Vienna. Certainly this can be done, simply by determining the hydrocarbons, which burn well in all lamps. These hydrocarbons are now well known. They are those which resist the action of hot (80°) commercial concentrated (66·5° Beaumé) sulphuric acid, or of cold Nordhausen sulphuric acid. Such hydrocarbons have been produced by Dr. Edeleanu by his carbon disulphide separation process, and have been obtained by me recently by filtration with argilaceous earths. These processes require considerable care as regards proportion of acid, duration, temperature, and method of agitation, &c., and I propose to describe a series of experiments on various distillates carried out in this way. I shall show that the quality so derived tends to approach very closely that obtained in nature with Pennsylvanian oil.

One can express the qualities of good illuminating oil in two distinct ways:—

(1) In terms of the quantity of hot sulphuric acid (66° B.) necessary to obtain a refined quality complying with a specific curve.

(2) In terms of the proportion of hydrocarbon that remains unattacked after titration with a quantity (Q) of acid during a time (t), and maintained at a constant temperature (T), and well agitated.

The first method leads to readily comparable results, and gives a very good idea of the chemical composition

* Paper to be presented at a meeting of the International Petroleum Commission to be held in New York, this month.

of the sample, but it takes much time and care; and the second is preferable as being a more rapid and precise means of classification.

II. Influence of Barometric Pressure on the Combustion of Illuminating Petroleum in the "Kosmos" Burner.

In the preceding section I have shown how the illuminating qualities of a sample of petroleum can be indirectly determined.

Since we are defining a good petroleum as one which can be burned in all kinds of lamps, it seems logical to select for purposes of test a type of lamp which is very sensitive to the quality of oil used. Among the various wick lamps having glass chimneys, the most generally used are those with round burners of the "Kosmos" type, and it is just this variety which is most sensitive to quality of the illuminant. Our choice, therefore, fell on this burner. The standard used throughout these tests was the Luchaire petroleum lamp.

There are, however, quite a number of varieties of such lamps in use, and slight modifications in design may affect the efficiency enormously. It seems desirable to specify their nature exactly, and we therefore reproduce in Figs. 1, 2, and 3 three types in use in France. It is also desirable to state the dimensions of the glass chimney and the quality of the wick; but this last factor can hardly be specified rigorously, on account of the diverse material and methods employed by different various manufacturers. Finally, as has been shown by the author in 1908, in a series of researches undertaken in conjunction with Mr. Madoule, the form and dimensions of the reservoir should be given.

After the representatives of the various nations had been placed in possession of these dimensions and all the constants, I believe that a number of years passed away without this question being taken up—I do not say numerous discussions, because the Congress at meetings in Bucharest in 1907, in London in 1910, and in Vienna in 1912, had the wisdom to avoid the matter. This discretion may be applauded, for researches undertaken with M. Dumesny have shown the existence of new complications.

The standard lamp of the Commission, even when burning the same quality of petroleum may yield misleading results owing to several unsuspected sources of error, such as may affect seriously researches now going on. The atmosphere in which such lamps are commonly burned, constituting as it does a variable mixture of nitrogen, oxygen, carbon dioxide, and water vapour, naturally influences the combustion of petroleum, and in addition to these factors the barometric pressure has been shown to exert an appreciable influence. We have found that quite different results would be obtained within a few days, and it was precisely on those occasions when the barometric pressure was lowest that the consumption per carcel-hour of the lamps tested was least.

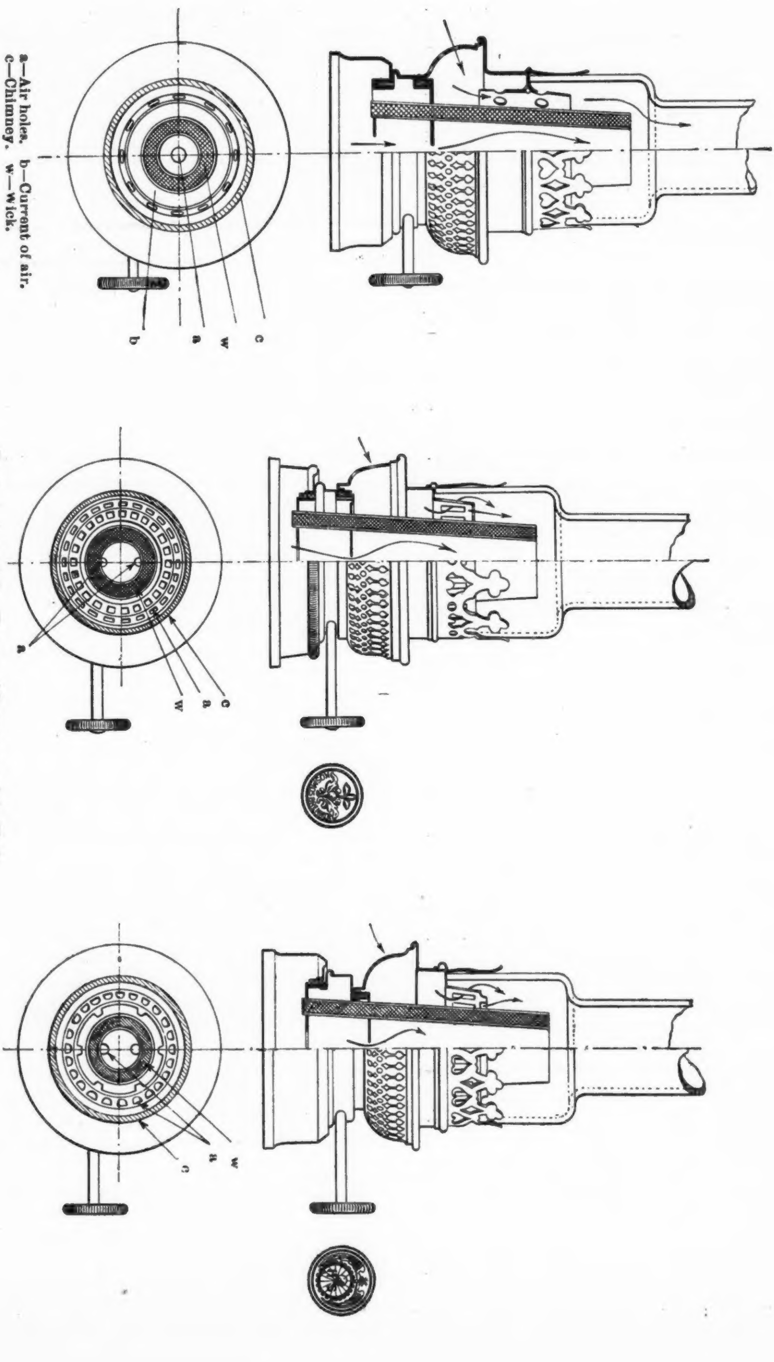
In order to verify this last fact I had a series of experiments made, extending over several years, in Rouen, Paris, and Cette. It may be added that in these experiments we have not been able to eliminate variations due to mounting temperature and presence of water-vapour; we have preferred to confine ourselves to the effect of barometric pressure, as we are disposed to consider that this variable exerts the most important effect.

Before proceeding to describe our results in detail, we may mention an instance of the effect of atmospheric conditions in practice.

It was stated by a commercial representative in the Midi district that oil from shale could only be successfully added to commercial petroleum at certain periods of theyear—for example, when the *mistral* was blowing; but that it would be injudicious to add large quantities when the wind was from the sea! These two periods correspond respectively to prolonged good weather and rain, so that the observation confirms the suggestion made above.

Results of Tests.

The first experiment was carried out at Rouen in March, 1912. Two



a—Air holes. b—Current of air.
c—Chimney. w—wick.

FIGS. 1, 2, and 3.—Forms of Lamps used in Tests.

days were selected on which the barometric pressures were widely different. Three lamps, each equipped with a Kosmos burner, were used, and two varieties of petroleum adopted, which gave the analysis indicated below. All tests were carried out with these same lamps, wicks, and chimneys.

TABLE I.

	Petrol No. 1.		Petrol No. 2.	
Density at 15 C.	$0·801^5$		$0·807^5$	
Flash Point with Luchaire Apparatus	40° C.		35° C.	
Colour	water white.		standard white.	
Analysis in Engler copper vessel with 200 cub. metres				
0—150°			2 p.c.	d=0 770
150—200°	41·9 p.c.	d=0·784	35 ,,	d=0·777
200—250°	37 ,,	d=0·804	28 ,,	d=0·804
250—300°	18·4 ,,	d=0·823	23 ,,	d=0·827
Residue above 300°	2·7 ,,	d=0·895	12 ,,	d=0·850
	100		100	
	March 12	19	March 12	19
Mean Baro. Press.	0·768	0·742	0·768	0·742
Mean Intensities (Carcel) of 3 burners:				
after One Hour	0·925	1·197	0·850	1·133
Three ,,	0·788	1·112	0·691	1·080
Six ,,	0 765	1·005	0 675	0·932
Nine ,,	0·687	0·835	0 613	0·744
Ten ,,	0·633	0·799	0·538	0 682
Mean Consumption per hour	34·6 g.	35·5 g.	33·3 g.	35·1 g.
Consumption per Carcel-hour	44·3 g.	34·6 g.	48·3 g.	36·56 g.

The difference in the results on March 12th and 19th respectively is very evident. Subsequently tests were made with ordinary petroleum on March 22nd-27th, and gave rise to the following results :—

TABLE II.

WITH KOSMOS BURNER (K).

Rouen Barometric Pressure	Mar. 22	Mar. 23	Mar. 25	Mar. 26	Mar. 27
	0·747	0·755	0·766	0·768	0·766
Intensity (Carcels) after 1 Hour	1·110	1·056	1·035	0·965	1 000
3 ,,	1·056	1·054	0·965	0·932	0 935
6 ,,	0·932	1·035	0·811	0·870	0·815
9 ,,	0·730	0·900	0·750	0·811	0·687
10 ,,	0·681	0·811	0·730	0·681	0·685
Mean Consumption	35·7 g.	36·8 g.	35·0g.	36·0 g.	34·5 g.
Carcel-Hours	9·457	10·061	8·781	8·833	8·477
Consumption per Carcel-hour	37·7 g.	36·8 g.	39·8 g.	40·7 g.	40·70 g.

WITH KOSMOS BURNER (H.S.).

After 1 Hour	1·195	1·232	1·195	1·056	1·195
3 ,,	1·280	1·195	1·110	0·965	1·110
6 ,,	1·280	1·150	1·056	0·870	1·056
9 ,,	1·000	0·965	0·932	0·750	0·811
10 ,,	0·840	0·870	0·875	0·681	0·681
Mean Consumption	40·5 g.	36·9 g.	36·8 g.	35·3 g.	36·0 g.
Carcel-hours	11·850	11·265	10 634	8·973	10·294
Consumption per Carcel-hour.	24·2 g.	32·75 g.	34·6 g.	39·35 g	34·95 g.

WITH KOSMOS BURNER (K.B.R.).

Intensity (Carcels) after 1 Hour	1·110	0·932	0·965	0·965	0·900
3 ,,	1·000	0·870	1·000	0·870	0·811
6 ,,	0·932	0·870	0·870	0·840	0·811
9 ,,	0·840	0·784	0·730	0·705	0·750
10 ,,	0·786	0·784	0·657	0·635	0·705
Mean Consumption	36·6 g.	34·9 g.	35·4 g.	34·9 g.	34·8 g.
Carcel-hours	9·588	8·609	8·828	8·186	8·112
Consumption per Carcel-hour	38·16 g.	40·53 g.	40·0g.	42·63 g.	42·91 g.

Apart from some inevitable small irregularities, one can affirm that, with the three Kosmos burners employed, the connexion between light yielded and barometric pressure is well established. On March 22nd and 23rd, when the barometric pressure was lowest, the strongest light and the lowest consumptions per carcel-hour were attained.

Seeing that the deviations due to the normal fluctuations in barometric pressure may amount to 10 or 15 per cent, the desirability of conducting comparative tests of illuminating petroleum *in the same lamps* and on the same day, or at least when the barometric pressure is sensibly constant, is evident. These conditions are not always easy to realize. In order to eliminate at a stroke all such effects, I propose to make tests invariably with a petroleum standard. Tests of combustion need no longer be considered as yielding absolute, but relative values. This fundamental principle I propose to present at the next Reunion of the International Commission.

In further confirmation of my contentions, I will now give the series of results obtained by M. Madoule of Frontignan (Herault) during a period of twelve days when the barometric pressure was practically constant. In this case, we shall see, the variations

are more feeble, but, nevertheless, even here the petroleum burned better and more economically when the barometric pressure was lowest. These results are summarised in Table III,

The constancy of these results is remarkable. They serve to show the precision attainable by an experienced worker. But in spite of the small differences in results, one sees that

TABLE III.

Frontignan	April 2	April 3	April 4	April 5	April 6	April 9	April 10	April 11	April 12
Barometric Pressure									
9 o'clock morning	757·9	765·0	765·9	768·4	763·8	751·4	756	757 1	759·2
6 „ evening	761·2	763·7	766	764 8	762·5	750·8	756·8	755 4	757·3
Average	759·5	764·3	766	766 6	763·2	751·2	756·4	756·2	758·2
Mean Intensity of 3 burners									
after 1 Hour	0·87	0 85	0·85	0·74	0·87	0·87	0·85	0·82	0·86
„ 2 „	0 84	0·82	0 79	0·74	0·82	0·82	0·85	0·75	0·84
„ 6 „	0·75	0·76	0·79	0·68	0·81	0·82	0·83	0·73	0·79
„ 9 „	0 59	0·64	0·72	0·63	0·76	0·74	0·75	0·67	0·67
„ 10 „	0·52	0·60	0·66	0·59	0 68	0·72	0·70	0·62	0·64
Mean consumption	36·03 g.	36·7 g.	35·7 g.	35·6 g.	34·6 g.	36 4 g.	36·3 g.	35·5 g.	36·9 g.
Carcel-hours	7·53	7·60	7·82	6·92	8 08	8·73	8·18	7 36	7·85
Consumption per Carcel-hour	47·85 g.	48 27 g.	45·72 g.	51·4 g.	42·85 g.	41 69 g.	44 45 g.	48·31 g.	47·0 g.

TABLE IV.—BURNER K.

	Petroleum No 1.				Petroleum No. 2.			
	March.				April.			
Paris	26	27	28	29	1	2	3	4
Barometric pressure ...	773/770	769/769	770/768	772/771	751/761	771/775	775/777	780/777
Mean	771^{5}	769	769	770^{5}	756	773	776	779
Intensity after 1 H. ...	1·00	1·00	1·10	0·97	1·17	1·14	1·03	1·10
„ „ 3 H. ...	0·97	0·97	1·06	1·00	1·17	1·17	1·03	1·06
„ „ 6 H. ...	1·00	0·97	1·10	0·97	1·14	1·17	1·10	0·97
„ „ 9 H. ...	0·88	0·85	1·00	0·91	1·03	1·10	0·91	0·68
„ „ 10 H. ...	0·82	0·91	0·97	0·85	1·00	1·06	0·85	0·66
Mean consumption ...	38·6g.	33·8g.	38·2g.	37·8g.	38 8g.	39·4g.	37·9g.	38·2g.
Carcel hours	9·6	9·00	10·5	9 6	11·26	11·29	10·17	9·25
Consump. per Carcel hr.	40·2g.	37·5g.	36·4g.	39·4g.	34·3g.	34·9g.	37·15g.	41·5g.

BURNER H.S.

Intensity after 1 H. ...	1·00	1·10	1·29	1·06	1·14	1·14	1·25	1·08
„ „ 3 H. ...	1·03	1·10	1·25	1·00	1·14	1·14	1·14	1·05
„ „ 6 H. ...	1·00	1·00	1·25	1·03	1·06	1·14	1·14	1·03
„ „ 9 H. ...	0·82	0·91	1·10	0·97	1·06	1·06	1·00	0·84
„ „ 10 H. ...	0 77	0 88	1 06	0·91	1·03	1·00	0·97	0·79
Mean consumption ...	38·6g.	38·2g.	40·7g	38·5g.	39·7g.	40·7g.	40·3g.	37·8g.
Carcel hours	9·61	10·22	12·18	10·11	10·94	11·17	11·25	9·99
Consump. per Carcel hr.	40·2g.	37·4g.	33·4g.	38·1g.	36·2g.	36·3g.	36·0g.	37·8g.

BURNER K.B.

Intensity after 1 Hour	1·03	1·10	1·21	1·00	1·17	1·17	1·00
3 „	1·00	1·14	1·21	1·10	1·17	1·21	1·14
6 „	1·00	1·14	1·21	1·06	1 06	1·25	1·10
9 „	0·82	1 00	1·10	0·91	1·06	1·06	0·91
10 „	0·80	0·94	1·06	0·85	1·03	1·06	0·88
Mean Consumption	37·9 g.	39·5 g.	40·5 g.	38·2 g.	39·5 g.	40·4 g.	40·0 g.
Carcel-hours	9·6	10·95	11·80	10·2	11·08	11·76	10·39
Consumption per Carcel-hour	39·5 g.	?6·08 g.	34·03 g.	37·4 g	35·6 g.	34·4 g.	38·5 g.

the lamps gave the maximum light on April 9th with a mean barometric pressure of 751 mm., and a minimum on April 5th with a pressure of 766 mm. In the first case the consumption per carcel-hour varied from 41·7 to 51·4 g., an increase of nearly 20 per cent. Finally, I add the results of tests made in Paris by MM. Entremont and Haudricourt on a good quality of *pétrole de luxe* (Table IV). These, again, lead to substantially the same conclusions.

These results confirm those given previously. It will be recalled that the variations in temperature and hygrometric state of the atmosphere have not been recorded, and these would doubtless help to explain any anomalies that exist. In conclusion, I would urge on observers the desirability of observing and recording the atmospheric conditions (barometric pressure, temperature, and hygrometric state) during their experiments. Exact particulars should also be given as to the conditions of the test—*e.g.*, whether the lamp is set up in a confined space or in the open, in the light or in darkness, &c. I have often observed that lamps which have burned quite regularly for some hours in darkness begin to flare when exposed to the rays of the sun.

Finally, I insist upon the necessity of employing as standards well-regulated lamps consuming a variety of petroleum and using a form of burner substantially the same as those employed in the lamp tested; in addition, the two sides of the photometric screen should be illuminated, as far as possible, by light of the same tint.

In conclusion, I may remark that I hope to return later to the question of the choice of a desirable form of standard. I believe that the differences in the results of observations on the same quality of oil so often recorded are largely attributable to this source of uncertainty.

Effect of Bad Hygienic Conditions on the Eye.

In a recent number of the *Zeitschrift für Beleuchtungswesen* it is pointed out that various conditions prejudicial to general health are particularly so to the eye. Among eye diseases which are the result of the nature of employment myopia is common. In the case of certain trades (compositors, mechanics, watchmakers, lithographers, engravers, &c.) there is a marked tendency to short sight. If this is only slight, it may not greatly hinder such workers from following their vocation. But between thirty and forty years of age an accentuation of this myopia commonly sets in.

As regards other defects, Dr. Schnaudigel, of Frankfort, attributes the eyesight trouble experienced by workers in mines partly to carbonic acid poisoning and there are other miners' diseases which appear to have the same effect. Poisoning, too, may have a damaging effect on the nervous system of the eye, and may lead to disease of the retina. For example, poisoning by lead, certain sulphur-hydro compounds met with in the fat and rubber industry, nitro-benzol, methyl-alcohol, and arsenic has such an effect, and even tea, tobacco, and vanilla may be prejudicial.

In glassworks the great heat from the furnace appears to lead to cataract of the eye, and certain chemicals have also a direct effect on the lens as well as the nervous system. The corroding effects on the eye of acids and alkalis are on the borderland between the categories of accident and disease of occupation. One must distinguish these from defects due to bad illumination.

The Lighting of a London Club.

By An Engineering Correspondent.

An interesting article might be written on the methods of illumination employed in various London clubs. Many of them have played an important part in the social life of this country in eventful periods of its history, of which they possess interesting relics. In some cases an effort has been made to maintain, or at least to imitate the methods of lighting in keeping with these old traditions; in others everything is up to date, and the lighting is essentially modern.

The influence of good conditions of illumination on the comfort of a club is considerable. Insufficient light to read by, bright, unscreened sources throwing their rays into the eyes of people seated round the room, ungainly, misplaced, and "makeshift" fixtures—all result in a subtle sense of discomfort, even when the onlooker does not realize precisely what is wrong. A recent writer has traced the discomfort of many modern club smoking-rooms to the glaring systems of lighting employed. It is a fact that many elaborately and expensively furnished rooms are still very poorly lighted. Yet the expense involved in providing good illumination is possibly less than 1 per cent. of the total annual turnover of a large club, and a little extra attention in this direction would be well repaid. For a club is primarily a social institution, and in attracting members relies to a great extent on the first impressions received by strangers during a casual visit.

By the courtesy of the Committee of the Whitehall Club permission was granted for measurements and photographs to be taken of the lighting in its new premises. The Whitehall Club was founded in 1862, and was originally located in Parliament Street. On January 22nd of the present year, however, the Club migrated from its temporary quarters in Whitehall Court to its new Club House in Princes Street, Westminster. We understand that the scheme for the lighting of the new building was planned by Mr. R. J. Wallis-Jones, M.Inst.C.E., M.I.E.E., a member of the Committee, who is also known to our readers as a member of the Council of the Illuminating Engineering Society.

The first view (Fig. 1) shows the main hall, which is effectively lighted by two 14-in. Holophane spheres placed at a height of about 12 ft. This type of fitting is well suited for the lighting of large halls and landings. The lighting of the staircase is effected by Holophane globes. The general illumination, both on the walls and on the floor, is about $\frac{3}{4}$ of a foot-candle.

A general view of the dining-room is given in Fig. 2. This room is in the shape of an "L," and has an area of approximately 1,600 square feet. It is lighted mainly by 6 six-light chandeliers hanging down the centre of the room, which are equipped with 20- and 40-watt frosted tungsten lamps and Holophane reflectors—a method which seems well adapted to a long, narrow room of this description. The greatest illumination (about 5 foot-candles) naturally occurs on the tables immediately under the chandeliers, but in the corners of the room is about 0·8–1 foot-candle. There are also nine bracket lights down the sides of the room, likewise using 40-watt tungsten lamps and Holophane reflectors.

The smoking-room and card-room, on the floor above, have together the same dimensions as the dining-room; the card-room can be partitioned off by folding doors.

Fig. 3 shows a general view of the smoking-room. The method of lighting is broadly similar to that in the dining-room, four six-light chandeliers

being used down the centre. Instead of side-lights, portable well-shaded lamps are provided on the writing tables, and several of these will be seen about the room. The restful effect of the lighting is assisted by staining the walls in plain mat colours. On the tables of this room a general illumination of 3·5 foot-candles is provided; on the side-tables, where the portable lamps are in use, a considerably higher value can, of course, be obtained.

In the card-room green silk shades are hung above each table, and there are also, beside the mantelpiece, a couple of bracket lights carrying tungsten lamps in Holophane reflectors. The illumination on the card tables was found to be about 2·5 foot-candles. The effect of the silk shades is naturally to leave the walls and surroundings in a comparatively subdued light, an arrangement which seems suitable for a card-room.

FIG. 1.—Whitehall Club: Entrance Hall, lighted with ungsten lamps and Holophane spheres.

FIG. 2.—Whitehall Club: Dining-room illuminated by chandeliers carrying tungsten lamps and Holophane reflectors.

FIG. 3.—Whitehall Club: Smoking-room, general lighting by tungsten lamp and Holophane reflectors. Local portable lamps on side tables.

In the billiard-room we have a somewhat similar problem, namely, to produce a relatively subdued general illumination and to concentrate the light on the tables, the actual lamps being, of course, completely screened from the eyes of the players. The general illumination is produced by a few bracket lights equipped with Holophane "residence" reflectors (which are satin-finished) and tungsten lamps. The two billiard tables are each lighted by six symmetrically placed local lights. Each unit consists of a 55-watt completely frosted tungsten lamp within a cardboard shade covered outside with green silk. Some care is needed in the choice of lamp and shades, and their arrangement at the correct height and distance apart. It is generally agreed that an exceptionally high illumination is necessary for a billiard table, and that the distribution of light over the table should be as uniform as possible. Yet the illumination, while uniform, should presumably not be "shadowless," for the player needs a certain amount of shadow to be cast by the ball in order to appreciate its position while aiming; on the other hand, no appreciable shadow should be cast by the cushions (such as might result, for example, from carelessly placed bright lights about the room).

In this case the general illumination is so subdued as to have relatively little effect on the lighting of the table, which depends entirely on the six shaded local lights. Measurements showed that on both tables the illumination was almost exactly 20 foot-candles underneath the lamps, and about 16-17 foot-candles between them from a practical standpoint this illumination may be considered uniform. The energy expended in lighting the table is about one-third of a unit, a value which experience suggests is necessary in order to illuminate a full-sized table effectively. It has been contended by some that, in order to secure uniform illumination, eight lights are really necessary; in this case, however, excellent results in this respect have apparently been secured with six.

FIG. 4.—Whitehall Club: Card Room.

The remainder of the rooms in the club are lighted by somewhat similar methods. The intention throughout has evidently been to secure soft and

restful conditions of illumination, frosted lamps and Holophane reflectors (frequently satin finish) being largely employed.

In conclusion, acknowledgment should be made of the courtesy of the Committee of the Club and of Mr. Wallis-Jones, and also of Mr. John Hodgkin, the Secretary, in granting facilities for these tests. The photographs shown in Figs. 1–4 were taken by Mr. V. H. Mackinney, while that of the billiard-room (Fig. 5) was taken by Mr. Hodgkin. In estimating the exposure reliance was, as usual, placed upon measurements with the Holophane Lumeter. The results may be considered quite satisfactory, the conditions of illumination in the room itself being faithfully reproduced, and the shape of the lighting fixtures correctly preserved.

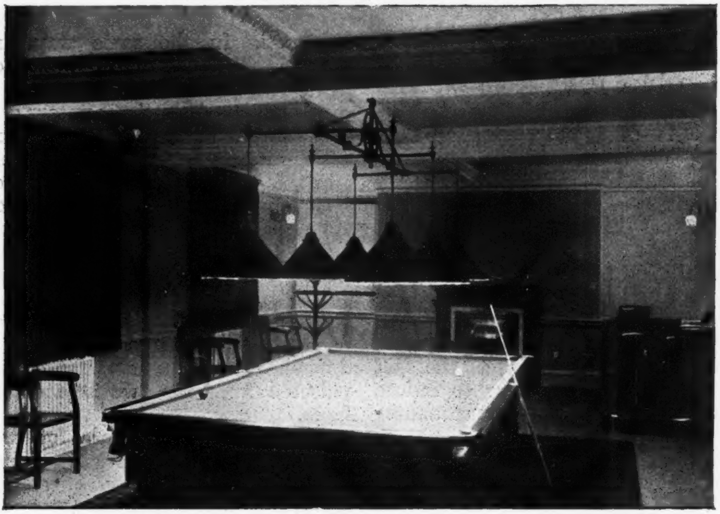


FIG. 5.—Whitehall Club: Billiard-Room. Six 55-watt completed frosted tungsten lamps employed.

Congress of the Textile Institute.

On Thursday, September 12th, the Congress of the Textile Institute opened at Hawick, and some very successful meetings were held. Visits to many of the adjacent textile factories were also arranged.

One of the most interesting items was the series of papers by four experts on the driving of mills by steam, gas, oil, and electricity—a method of treatment which resembles that sometimes adopted at meetings of the Illuminating Engineering Society (whose Hon. Secretary, Mr. Leon Gaster, was present).

A question which might well be studied in a similar manner is the lighting of textile works. Not only are there many general problems to be discussed, but there are also special matters, such as the colour of illuminants and the use of "artificial daylight," on which much remains to be said. We note that the meeting of Congress next year will take place in London.

Simultaneous Colour Contrast.

An interesting paper on this subject was recently presented to the Royal Society by Dr. F. W. Edridge-Green.* The effect of adjacent colours on one another is of some interest to the lighting engineer, and it may be recalled that this point came up for discussion at a recent meeting of the Illuminating Engineering Society devoted to 'Colour Discrimination by Artificial Light.'

From a scientific standpoint these phenomena are also important, in view of their bearing on the theory of colour vision. For example, the fact that strong colours appear to induce the complementary tint in surrounding objects has been adduced to support the Hering theory. Dr. Edridge-Green, however, contends that it does not do so.

Experiments on simultaneous contrast require considerable care. For example, we must distinguish the effect from that of a chromatic aberration. All colours cannot be equally well focussed by the eyes, so that small, diffusing circles may extend outside the image of a certain object on the retina and influence the colour of adjacent images. In a mosaic of small pieces of coloured cardboard the effect of the mixture of lights is very noticeable. In the same way the lights observed should not flicker, for in this case we may get successive contrast; also the luminosity of adjacent colours should not be widely different.

Dr. Edridge-Green describes some very curious and suggestive experiments. One of his conclusions appears to be that it is not possible for a colour such as red to be produced by another one unless it is present to some extent. This was verified by observing various colour contrasts from a pair of blue-green glasses which transmitted no red rays. In the same way, in a photographic dark room lighted only by a red light, we do not find any surface in the room that appears green, and it is only with the introduction of some foreign light that this colour appears. In short, simultaneous contrast may *exaggerate* a colour, but does not produce it.

The following are the chief conclusions given at the end of this paper :—

1. The colours seen by simultaneous contrast are due to the exaggerated perception of a real, objective, relative difference which exists in the light reflected from the two adjacent surfaces.

2. A certain difference of wave-length is necessary before simultaneous contrast produces any effect. This varies with different colours.

3. A change of intensity of the light of one colour may make evident a difference which is not perceptible when both colours are of the same luminosity.

4. Simultaneous contrast may cause the appearance of a colour which is not perceptible without comparison.

5. Both colours may be affected by simultaneous contrast, each colour appearing as if moved further from the other in the spectral range.

6. Only one colour may be affected by simultaneous contrast, as when a colour of low saturation is compared with white.

7. When an incorrect conception of the saturation or hue of a colour has been made, the contrast colour is considered in relation to this false estimation. That is to say, the missing (or added) colour is deducted from (or added to) both.

8. A complementary contrast colour does not appear in the absence of objective light of that colour.

9. The negative after-images of contrasted colours are complementary to the colours seen.

* *Proceedings* of the Royal Society, "B," vol. lxxxiv., 1912.

The Moore White Light.

INCLUDING SOME PARTICULARS OF THE FIRST INSTALLATION IN LONDON.

IT will be recalled that in the early part of this year the Illuminating Engineering Society devoted an evening to the subject of 'Colour Discrimination by Artificial Light.' The effect of various illuminants on the appearance of coloured objects was much discussed, and a new form of screen for use with tungsten lamps, in order to produce "artificial daylight" was shown for the first time.

An illuminant which has received much attention in the United States as a means of producing white light is the Moore tube. Mr. Macfarlane Moore, the inventor, read a paper on the subject before the American Illuminating Engineering Society in 1910, which was noticed in this journal.* The lamp consists in a long tube containing suitable gases at a low pressure (about 1-10,000th atmosphere), which is subjected to a high-tension discharge. The tube is commonly $1\frac{3}{4}$ in. diameter, and may be 60–100 ft. in length. When nitrogen gas is used a yellow light is obtained, but with carbon dioxide the quality is said to be almost exactly similar to daylight. This has led Mr. Moore to suggest that the

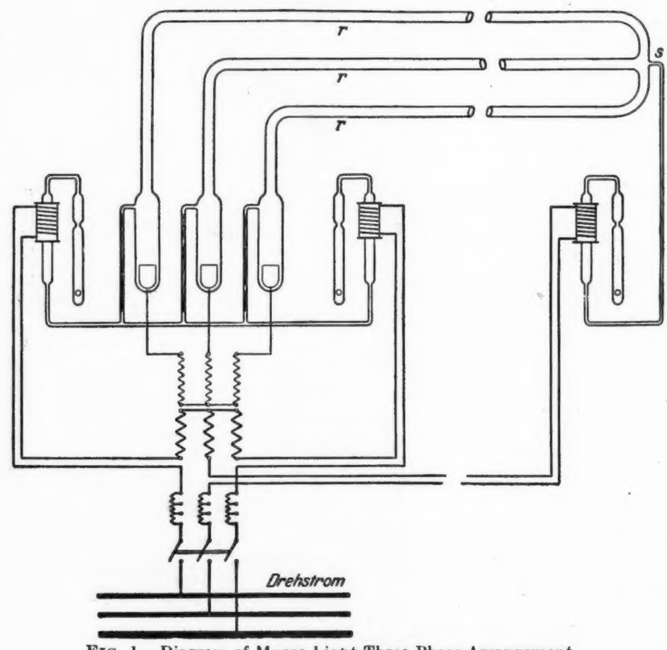


FIG. 1.—Diagram of Moore Light Three Phase Arrangement.
r r r luminous tubes; s feeding tube.

* Vol. III., 1910, p. 668.

lamp should be adopted as a standard white light, since the colour should always be identical provided the nature of the gas inside the tube and the electrical conditions are maintained constant. The essential feature of Moore's invention, which enables this constancy to be maintained, is the provision of an automatic valve which admits carbon dioxide to the tube from a small vessel so as to keep the pressure within absolutely constant. This valve is ingeniously regulated by an electro-magnetic solenoid, which in turn responds to any slight variation in the current passing, and feeds as a rule about every ten or twenty seconds. When alternating current is available the installation of the lamp is quite simple. The extremities of the tube are connected to a high-tension transformer (which is boxed in out of the way), and the tube emerging from it ramifies round the room in any desired direction. When only direct current can be obtained, it is necessary to introduce a rotary converter in order to generate alternating current. It is said that the lamp can operate on frequencies as low as 25 without undue flickering, but a value of 50 or more is preferable.

Single-phase installations are usual in the States, and are said to be quite satisfactory as regards steadiness on a reasonably high frequency. When machinery or moving objects are to be illuminated, however, a three-phase arrangement is recommended, as this obliterates any tendency to stroboscopic images owing to the cyclical variations in the light. A plan of a three phase installation is shown in Fig. 1.

The following particulars furnished regarding the consumption and light of standard white tubes may be of interest :—

Phase.	Length of Tube.	Candles (Hefner).	K.W. Consumed.
Single	66 ft.	800	2·8–3·2
,,	83 ,,	1000	3·1–5·5
,,	100 ,,	1200	3·6–3·75
Three	125 ,,	1500	4·0–4·7
,,	150 ,,	1800	4·5–5·4

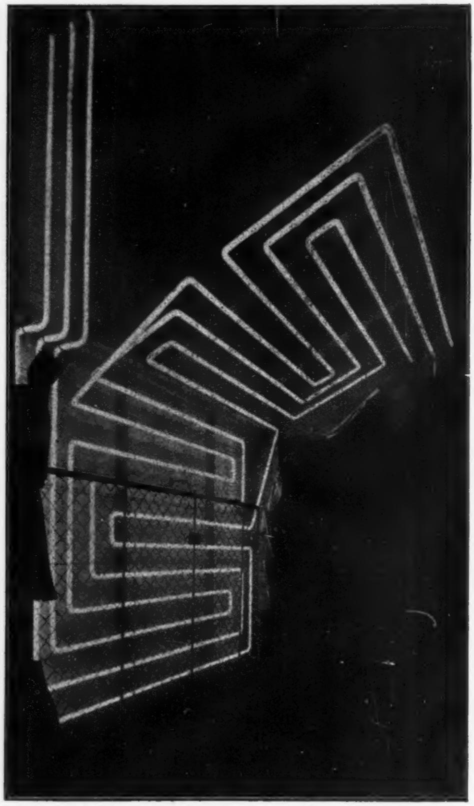


FIG. 2.—Moore Outfit for Photographic Studio. The tube is coiled into a comparatively small area.

On this basis the specific consumption would be about 3½ watts per English candle. It is usual, when arranging installations, to allow about 9 candles (Hefner) per square foot.

In many cases the value of a genuine artificial daylight is unquestionable. In many industries accurate colour matching is only possible by daylight

conditions. Without some form of "artificial daylight" work has to be suspended when natural light fails, and this is a considerable drawback in the short winter days. Again, natural light is always uncertain. Even in the summer time mist and fog (and in towns, smoke) alter its colour to some extent, and on an exceptionally cloudy day the light may not be strong enough for accurate work. A good artificial daylight, on the other hand, should be always available and constant.

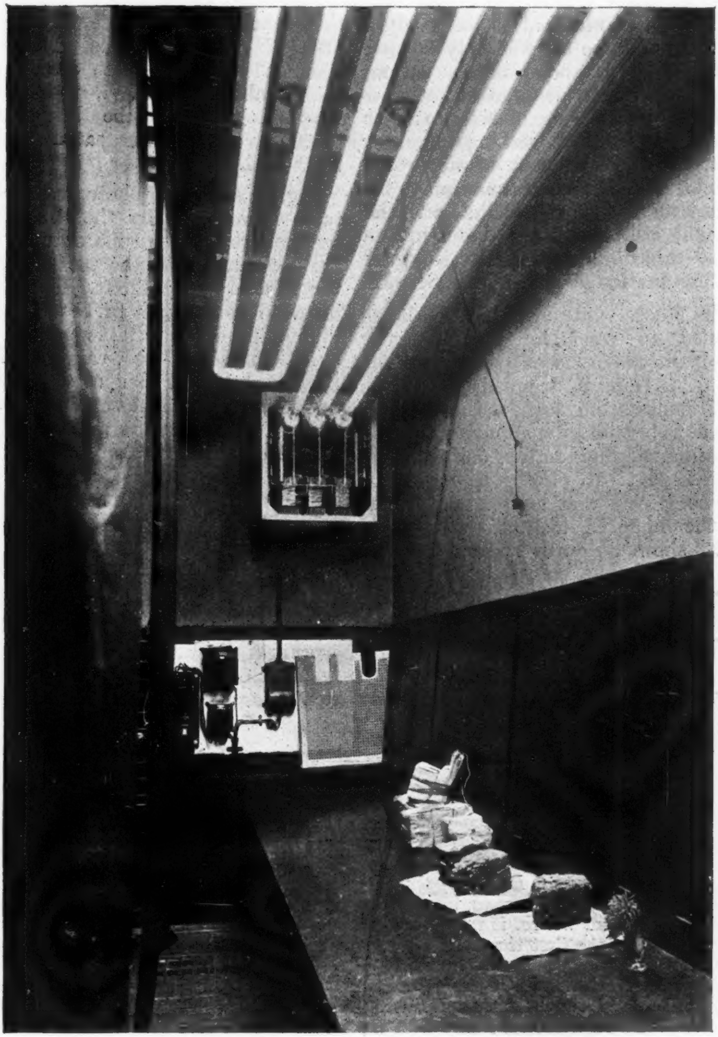


FIG. 3.—Moore White Light Three Phase Installation in the Offices of a well-known firm of Hop Merchants. The first installation of the kind in London.

As an illustration of the numerous operations which require daylight for

colour-work one may mention silk, ribbon, and colour-printing, dyeing, colour-printing and lithography. But there are many other industries, such as the grading of coffee, tobacco, and hops, in which the exact colour and shade of the material is very vital. In many of these cases it may be well worth while to spend money on an adequate daylight-installation, in view of the industrial gain of being able to prolong the hours of working and carry on accurate colour-work whatever the outside climatic conditions may be. It may be also suggested that artificial daylight will eventually be found of considerable value to artists, and for the illumination of picture galleries, &c.

The Moore white light, besides being claimed to resemble daylight very closely in colour, is also like it in the fact of its being so "spread-out." The light comes from such a considerable area as to be almost shadowless, thus resembling the illumination derived from a white sky. In photographic studios the constancy and high actinic value of the light is also an advantage. Fig. 2 shows an outfit for this purpose, the tube being coiled in a special shape, so as not to occupy too large an area.

Until recently the Moore light has not been developed in England, although it is stated to have been widely used in the United States, and to some extent in Germany. We understand that the General Moore Co. are introducing the system in this country, and by their courtesy were afforded an opportunity of inspecting an installation at the premises of a well-known firm of hop merchants in London. This is a three-phase installation, taking about 4½ K.W., the pressure supplied to the tube being about 18,000 volts. The rated light is 1500 H.K.

Fig. 3 shows a photograph of the table illuminated by the tube (taken by the light of the tube only). There are six bends, and the total length of the tube is about 125 ft. The tube is installed at a height of 11 ft., and the illumination on the table proved to be a little under 10 foot-candles. In the background will be seen the case containing the transformer (open). The valves feeding the tube and the adjacent receptacles from which the supply of carbon dioxide is derived will also be noted.

We understand that this is the first white light Moore installation in London, but that a certain number of installations have been fitted up in the provinces, particularly in the textile works at Bradford. It will be interesting to observe the progress of this new illuminant.

Some Publications Received.

The Third Annual Report of the International Electrotechnical Commission, up to December 31st, 1911, makes interesting reading. It contains an account of the meeting at Turin, where, it may be remarked, the British Government was officially represented for the first time, and an excellent photograph of the esteemed President, Prof. Dr. E. Budde. Reference is made to the fact of the subject of illumination having been considered: "In view of the close relationship between Illuminating Engineering and the Electrical Industry, and the desirability of close Co-operation, the I.E.C. has expressed a desire that the Local Committees put themselves in touch with the societies in their respective countries, which are studying the subject of the unification of the terms employed in all questions relating to illumination."

The History of Fire-Making. A catalogue of an illustrative exhibit consisting of specimens selected from the collection formed by Edward Bidwell, shown in the Science Section of the Anglo-Indian, Anglo-Japanese Exhibition at Shepherd's Bush, London, 1911. (O. E. Janson & Son, 44, Great Russell Street, London, W.C.; 1*s*. net.)

Notes on the Quartz Mercury Vapour Lamp.

BY AN ENGINEERING CORRESPONDENT.

THE recent introduction of silica mercury vapour lamps in this country has naturally attracted much attention, and some particulars of the underlying principles of the lamp may be interesting.

The development of the quartz mercury vapour lamp was not really controlled by the completion of any particular research on the properties of the mercury vapour arc, but by the perfection and commercial development of transparent quartz tubes. This industry has already reached a high degree of efficiency, but owing to the essential processes of manufacture the cost of the product is high.

The advent of the quartz mercury vapour lamp constitutes a marked advance in the field of electric illuminants. The light is originated by the luminescence of a column of mercury vapour situated between two mercury electrodes in a tube of transparent quartz, which tube is exhausted to a high degree of vacuum; this is known technically as the burner. The starting is effected, as in the Cooper-Hewitt lamp, by tilting the burner so that a stream of mercury, flowing along the length of the tube, establishes a short-circuit between the electrodes. When the stream of mercury is broken an arc is formed, and a quantity of mercury is vapourized; this extends from one electrode to the other, the burner returning to its normal position.

In view of the fact that in the ordinary illuminating lamp the tilting is effected automatically by the aid of an electro-magnet, the lighting is as simple as that of an incandescent or arc lamp, it being only necessary to close the switch.

The chief advantage of these lamps lies in their high efficiency of operation, namely, 0·25 to 0·30 watt per c.-p. Hitherto such an efficiency has only been attained with flame arc lamps, but these have certain comparative limitations, such as difficulty in operation of a number of lamps in series, rapid consumption and high cost of carbons, and frequent cleaning of the globes. Now, once the quartz lamp is started, it requires no attention. The burner is guaranteed for 1,000 hours, but the average life is stated to be actually longer. Furthermore, it is never necessary to clean the globe. In addition to the high luminous efficiency, the lamp has the advantages that the tube only requires replacement at rare intervals, and the lamp needs no attention while working. Lamps can also be operated in parallel on 110 volts or 220 volts, or on traction circuits of 460 to 600 volts. These advantages are claimed to outweigh the comparatively high first cost due to the high value of the raw material.

The curve in Fig. 1 explains the object in replacing glass by a material so costly as fused quartz.

This curve shows how the specific consumption (watts per candle-power) of a mercury vapour lamp varies with the vapour pressure. To increase the pressure it is sufficient, for example, to restrict the cooling of the lamp; the temperature rises, and the pressure with it.

It will be seen that the efficiency, after having touched an original maximum value " A," afterwards decreases and touches a minimum value, and then again decreases, and for a pressure of about 1 atmosphere reaches a value below that indicated by the point " A," which was at one time believed to be the point of maximum efficiency. The Cooper-Hewitt lamp operates at the point indicated as " A," the glass of which the tubes are made being capable of withstanding the pressures and temperature corresponding thereto. In

order to attain higher values, such vapour pressures and temperature are necessary that any ordinary glass tube would be melted. Consequently transparent quartz, having a melting point about 1,800° C., is used, and is found to be quite satisfactory in practice. In these circumstances the lamp will operate near the point "C."

The high temperature has the additional advantage of improving the colour of the light. The illumination produced is much whiter than in the case of the Cooper-Hewitt glass tube.

The spectrum of the mercury arc is rich in ultra-violet rays, owing to the fact of quartz being transparent to such radiation. It is on this account largely employed in sterilization and in chemical industries in which the action of the ultra-violet rays is utilized. In the Cooper-Hewitt lamp such rays are cut off by the glass tube. When the quartz lamp is used for ordinary illuminating purposes the burner is enclosed in a glass globe which cuts off all the ultra-violet rays. Such diffusing globes are used with the silica lamp.

The substitution of quartz for glass creates some rather serious difficulties in manufacture. The chief of these difficulties is in the method of conducting the current to the interior of the burner and obtaining a seal which will efficiently maintain the interior vacuum.

In the case of glass (Cooper-Hewitt lamps, incandescent lamps, and Röntgen bulbs) it is sufficient if a platinum wire is sealed into the glass. The coefficient of expansion of platinum approaches closely to that of certain kinds of glass, and, by taking certain precautions, it is possible to obtain a seal which will not break down when the lamp heats or cools.

With quartz this no longer holds good, the expansion of quartz being almost 0–0·4 micron per degree per metre, as compared with 8·0 microns in the case of platinum—a ratio of 1 to 20. In consequence all platinum seals in quartz break after a more or less short period.

This difficulty was solved by the use of "invar," an alloy of steel and nickel invented by Mr. C. H. Guillaume. This substance has the comparatively low expansion of 0·8 micron per degree per metre, which closely approximates that of quartz. Unfortunately, invar is forged metal, which loses its properties when brought to red heat; it is, therefore, impossible to make the seal in the same manner as with platinum. The method adopted is to grind in a tapered rod of invar into a conical quartz tube, and in this way form a mechanical seal. This is protected by a mercury cup, the mercury being retained by bitumen or cement.

The fall of potential at the surface of the anode being greater than at the surface of the cathode, the temperature of the former is always higher than that of the latter, and there is, therefore, a tendency for the mercury to be gradually carried from the anode towards the cathode.

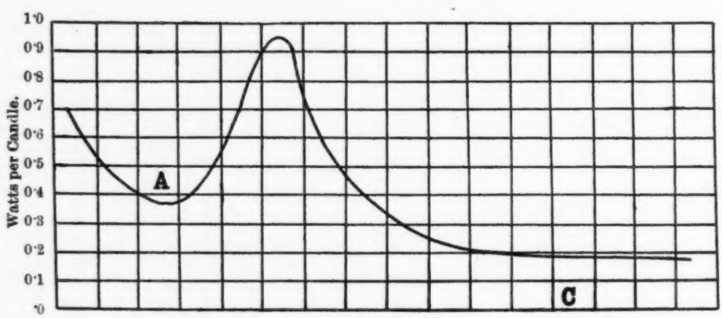


FIG. 1.—Showing the Improvement in Efficiency of the Quartz Tube as the Power given to the Lamp is increased.

The first and simplest method of preventing the accumulation of mercury at the cold electrode is to place this on a higher level than that of the hot electrode; when the mercury accumulates there it overflows and returns to the lower electrode. Unfortunately, in the quartz lamp such transference of liquid mercury results in extinguishing the burner; the relatively cold mercury from the electrode, in passing through the hot luminous tube, partly vaporizes and causes a sharp rise in the internal pressure, which extinguishes the arc.

Some compensating means for maintaining the levels of the electrodes constant in spite of the difference in their temperatures is therefore necessary. For this purpose a conical restriction is formed at the negative electrode, the apex of which should be towards the luminous tube (Fig. 3).

If the mercury happens to accumulate in the negative electrode, the level rises in the cone, the arc is formed over a smaller surface, a higher temperature is attained, and, the vaporization becoming more active, prevents the accumulation of the mercury.

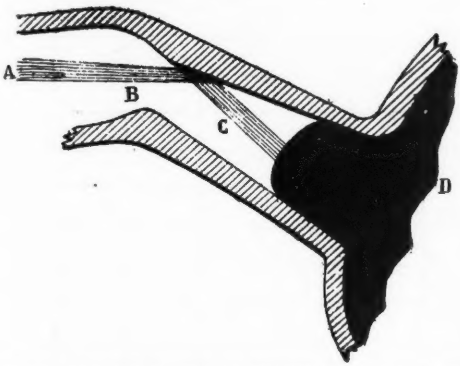


FIG 3.—Showing method of Maintaining Levels of the Electrodes Constant by means of Conical Restriction in Tube.

The reverse action takes place if the level falls, and with a properly dimensioned cone this arrangement operates perfectly.

The number of watts consumed in the passage of the current is high—630 watts in the case of the 220-volt lamp, and 320 watts in the case of the 110-volt lamp. It is essential to ensure the cooling of the burner if the pressure is not to attain too high a value. This cooling is obtained either by providing


FIG. 2.—Showing method of inserting "Invar" Conductor into Quartz Glass.

the electrodes with metallic vanes, which dissipate the heat as in a radiator (Fig. 4), or by fitting the burner with a chamber in which the mercury vapour condenses and falls back into the electrode in liquid form.

The operation of the burners varies slightly with the exterior temperature; when this is low the cooling is more rapid, and the current passing through the burner, for an equal difference of potential at the terminals, is greater. In burners where the cooling is obtained by means of vanes, it is necessary to have the vanes rearranged for outdoor use; where a condensing chamber is used, its temperature is always so high as to ensure the amount of heat dissipated being very little influenced by variations in the outside temperature.

The current of the lamp is adjusted to the required value by making the vanes or condensing chamber of suit-

able dimensions. This regulation, however, also depends on the surface of radiation of the luminous portion.

Fig. 5 represents the characteristic curve of a burner. The curve becomes rapidly parallel to the ordinate in the region of normal operation. As a matter of fact, the 110-volt lamp operates with considerably less than this pressure across the tube terminals, the difference being absorbed by the resistance fitted in series with the burner. An examination of the characteristic curve shows the necessity of effecting regulation of the series resistance by means of a voltmeter across the tube terminals. An adjustment secured by placing an ammeter in the circuit is in no sense satisfactory.

The voltage drop across the burner is independent of the current density; it depends on the vapour pressure, which is in turn connected with the temperature. Assume that the burner is operating on 110 volts, and is adjusted for 50 volts at the tube terminals, it will consume 3·42 amps., and its manner of operation will correspond to point "A" of the characteristic. The series resistance absorbs 60 volts. It equals, therefore,

$$\frac{60}{3{\cdot}42} = 17{\cdot}2 \text{ ohms.}$$

If the series resistance is abruptly lowered from 17·2 ohms to 15 ohms, it will be noticed that the pressure at the tube terminals does not vary; the

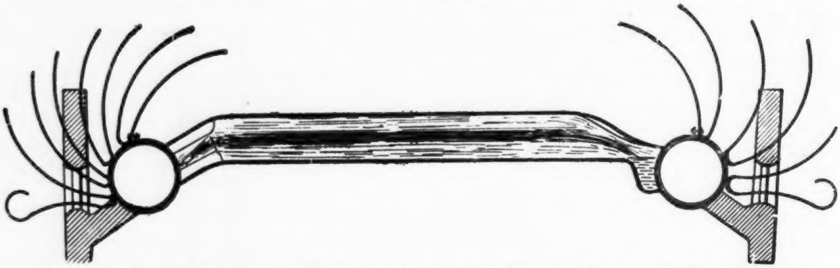


FIG. 4.—Showing Metal Vanes for Conducting away the Heat and keeping the Temperature of the Tube within limits.

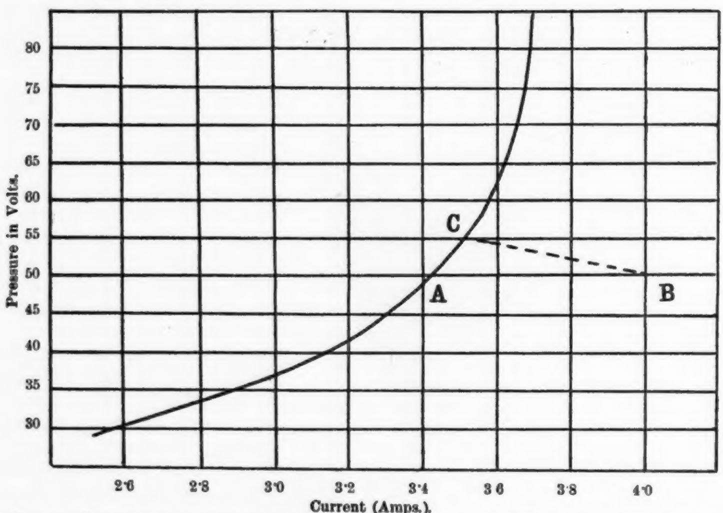


FIG. 5.—Showing characteristic Curve connecting Pressure and Current of Quartz Tube.

series resistance must always absorb 60 volts; the current rises to

$$\frac{60 \text{ volts}}{15 \text{ ohms}} = 4 \text{ ampères};$$

and the operation of the burner is at point "B." The burner is, however, not operating normally, as the consumed watts have considerably increased. The temperature rises, and, after a few minutes, the burner is found to be in operation at point "C," after having passed through all the intermediate phases characterized within the region B C. This phenomenon is noticeable at the moment of lighting up, when the lamp is cold and the internal pressure is low. The volts absorbed by the burner are then also low, and, since the series resistance has the value which will be necessary when the burner is started, the initial current is high.

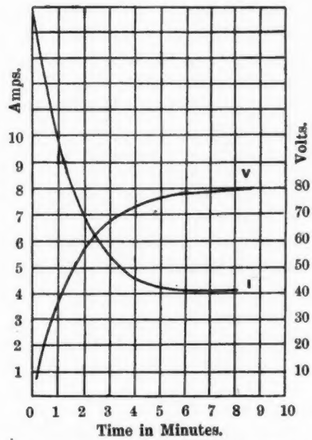


FIG. 6.—Showing alteration in Pressure and Current consumed by Tube after Lighting Up

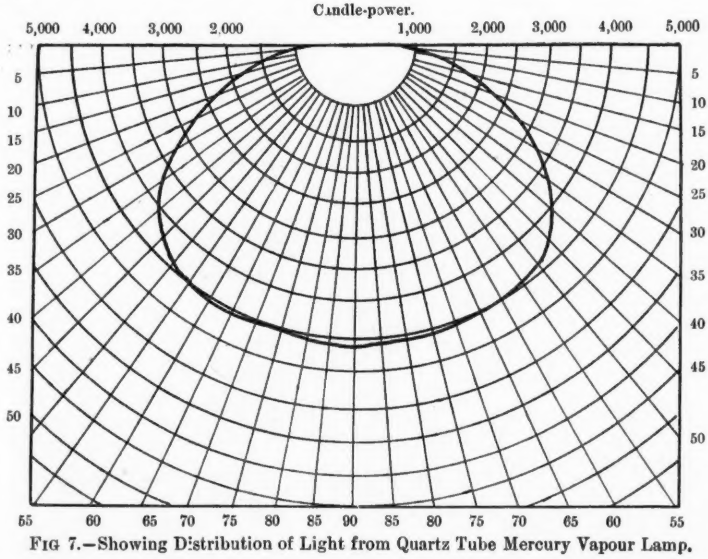


FIG 7.—Showing Distribution of Light from Quartz Tube Mercury Vapour Lamp.

Fig. 6 shows how the current and pressure vary as a function of the time at the terminals of a 110-volt burner, the series resistance of which is adjusted for operation on 80 volts 4 amps.

The pressure at which a burner normally works must be limited, so that the burner will relight in the event of it being extinguished through excessive voltage fluctuation. An examination of the curves will show that the values selected are such as produce the highest commercial efficiency.

Should a burner be operated on still higher voltages at the terminals, a value is attained which may be called the "critical point," beyond which the

burner will not relight without a certain time elapsing in which it may cool; otherwise, only a short arc will be struck, which goes out before reaching either one electrode or the other. The full explanation of this phenomenon has been already indicated. Briefly, with the burner operating on the higher pressures, the luminous tube becomes very hot, and the cold mercury from the electrode entering the tube produces an intense vaporization. This raises the pressure to such a value as to form an arc, which requires a voltage *higher than that of the line pressure.* This theory is confirmed by the fact that the "critical point" of a 110-volt burner, which is 95 volts when operating on a line pressure of 110 volts, exceeds 120 volts when operating on a 220-volt supply.

Fig. 7 shows the distribution of the light emitted by a 220-volt burner in a vertical plane passing through the axis; a portion of the light is obstructed by the lower portion of the electrodes.

A New Form of Mercury Vapour Lamp.

In a recent number of the *Elektrotechnische Zeitschrift** Dr. J. Pole gives an interesting account of the new form of "orthochromatic" mercury vapour lamp introduced by the Cooper Hewitt Electric Co. in the United States, to whose courtesy we are indebted for the illustrations accompanying this article.

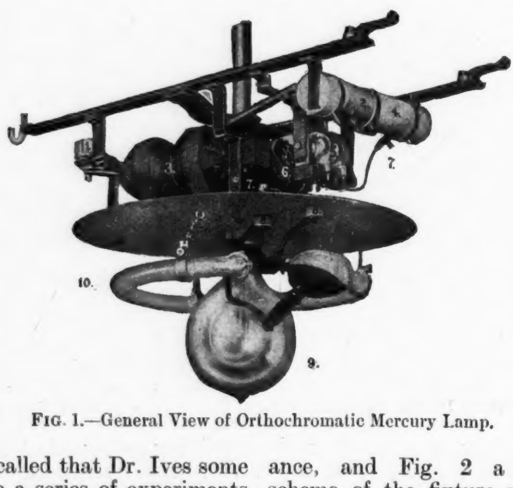


FIG. 1.—General View of Orthochromatic Mercury Lamp.

It will be recalled that Dr. Ives some time ago made a series of experiments on the colour of light derived from combinations of tungsten and mercury vapour lamps. He showed that by mixing the light from these two illuminants in the right proportions a colour apparently not far removed from daylight could be obtained; this, at least, was the impression received by the eye.

This idea has now been developed to a more practical stage, the tungsten and mercury lamp being combined together in a very compact form of unit. Fig. 1 shows its general appearance, and Fig. 2 a diagrammatic scheme of the fixture with the globe on. It will be observed that the mercury tube is circular and the tungsten lamp is mounted at its centre. The two lamps are in series, the tungsten filament being arranged to act as ballast resistance, thus

* May 9, 1912.

reducing the power usually lost in this way. A feature of the lamp is the new method of starting. A reversion has been made to the "inductive discharge" method. There are two mercury electrodes in vacuum vessels which are normally short-circuited. When the P.D. is applied to the lamp the current flows through a solenoid, which gives the vessels a twist, thus separating the electrodes and momentarily breaking a highly inductive

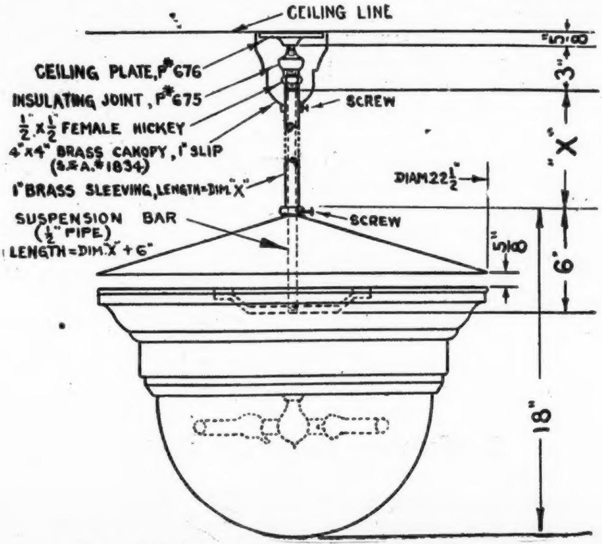


FIG. 2.—Method of arranging Lamp in Diffusing Globe.

FIG. 3.—Office Installation of Orthochromatic Mercury Lamps.

circuit. The momentary rise of P.D. thus developed is applied to the terminals of the main tube, and suffices to start the conduction. Its action is assisted by a small condenser arrangement. The advantage of this method is that no rocking is necessary, and the mercury tube is kept stationary throughout.

The two lamps are enclosed in a diffusing bowl. This serves to mix the two qualities of light, so that its surface appears white and evenly illuminated all over. Fig. 3 shows a view of an office illuminated with these units. The resistance and starting mechanism are conveniently packed away in the small space covered by the broad rim of the bowl. (See Fig. 2.)

These "orthochromatic" lamps are made for 110 volts, and Dr. Pole gives the following particulars of their performance :—

Terminal voltage ..	110 volts.
Voltage applied to tube	56 volts.
Current	2 amps.
Mean hemisph. C.P. (with diffusing globe)	300 H.K.
Specific consumption (mean) ..	0·73 watt per H.K.
Absorption of light by globe ..	25 per cent.

A Mercury Cadmium Lamp.

Yet another attempt to improve the colour of the mercury lamp is announced by Dr. M. Wolke,* who finds that he can supply the missing lines in the spectrum by the addition of cadmium. The attempt to introduce foreign metals into the mercury tube with this object has been tried before and failed. But it is stated that the early difficulties have now been overcome.

The metal to be added, besides furnishing the missing red rays, should vapourize (but not necessarily melt) at a comparatively low temperature. This is essential, with a view to high luminous efficiency and because, if the temperature of the vapour is not less than that of the tube itself, a permanent obscuring deposit will be formed. Another point to be noted is that the metal should not have any chemical affinity for quartz, otherwise the tube will be attacked.

Zinc and cadmium were selected as the most hopeful metals with which to experiment, but the former soon proved unsatisfactory. Cadmium, on the other hand, seems to possess the needed qualities. It does not attack quartz. It does, it is true, form a deposit on the tube, but this only takes place in the cold state and disappears as the tube heats up. The cadmium must, however, be absolutely pure. An addition of only 3–10 per cent of mercury, according to the size of the lamp, is necessary. The wave-lengths present are as follows :—

Metal	Wave-length	Colour
Mercury	0·405	Violet
"	0·409	
"	0·436	Blue
Cadmium	0·468	
"	0·480	
Mercury	0·492	Green
Cadmium	0·508	
Mercury	0·546	
"	0·577	Yellow
"	0·579	
Cadmium	0·644	Red

The resulting colour is stated to appear to the eye as white as that of an arc lamp, and to reveal the colours of surrounding objects in apparently natural tints. The efficiency is also stated to be comparable with that of the quartz lamp, being, with the 600-watt type, under 0·2 watt per H.K.

Particulars are also given of experiments with various forms of starting devices. The electrodes being solid in this lamp, the starting up presents distinct difficulties which are absent in the mercury lamp proper. One of

* *Elektrot. Zeitschr.*, Sept. 5, 1912.

these is distinctly novel and utilizes the deposit formed on the cold tube. This metallic layer enables the lamp to conduct before the metal is vapourized, and the resultant ionization soon leads to complete starting up of the lamp; when the lamp has heated up the metal deposit disappears. This method is only applicable with metal electrodes. Experiments have also been made with a graphitic anode. In this case the tipping method is applied, the graphite being attached to an iron chain. When the lamp is tipped the graphite anode slips down the tube and makes contact with the cathode; as the lamp is rocked back again it recedes to its former position at the end of the tube.

It will be interesting to see how this new lamp developes and how far its qualities are maintained during life.

Educational Announcements.

The Polytechnic (307–311, **Regent Street**) again announce a special course of 12 **lectures on illuminating engineering,** under the supervision of Mr. Leon Gaster, on Friday evenings at 7.30 P.M. The subjects dealt with include lighting by gas, electricity, acetylene, oil, and petrol-air gas, the effects of light on the eye, the measurement of light and illumination, and practical problems in illuminating engineering. The first six lectures are to take place before Christmas, and commence on October 25th; the second half of the course begins on January 17th. The lecturers are Messrs. W. C. Clinton, J. G. Clark and E. Scott Snell, Dr. W. J. Ettles and Mr. J. S. Dow. The syllabus of the lectures can be obtained on application. Fee for the entire course 12*s*. 6*d*.

Other subjects dealt with in the Polytechnic School of Engineering include special courses on mechanical and electrical, gas, aero, civil, motor-car, and locomotive engineering. There are also special courses in practical mathematics.

University College (**Gower Street, London, W.C.**).—A special course of 24 lectures on Electrical Design by Mr. E. Kilburn Scott will take place on Tuesdays at 5 o'clock, commencing on October 15th; fee for the course £2 2*s*.

East London College (**Mile End Road**).—Special facilities are offered for research in electrical and mechanical engineering for both day and evening students. The session commences September 30th. Applications should be made to Prof. J. T. Morris, M.I.E.E., or Prof. Dr. D. A. Low, M.I.M.E.

Westminster Technical Institute (**Vincent Square, Rochester Row, S.W.**).—Prospectus for session 1912–13 includes particulars of the course on gas engineering, which is a special feature. Other subjects dealt with include architecture and construction, building, cabinet making and design.

Among other announcements we note particulars of the evening classes in electrical engineering at the Northampton Institute (Clerkenwell, E.C.) and the technical classes at St. Bride Foundation Institute (Bride Lane, Fleet Street, E.C.) on printing and lithography.

The Sun as Spring-Cleaner.

It has been pointed out in *The Lancet* that the brilliant spell of sunshine which came just in the midst of the recent spring-cleaning season was of great value to the housewife. The sun is one of the best possible disinfectants, for sunlight is fatal to most of the pathogenic bacteria, and hence is a useful aid in cleaning operations.

Illumination and Visual Acuity.

In the course of an investigation into defects of vision among school children in Liverpool some interesting results were obtained, showing the effect of poor illumination on vision, and we print below a note on these results which appeared recently in *The Medical Officer* :—

At Liverpool last year, in the endeavour to find some of the factors upon which acuity and defects of vision depend, the eyesight of a certain number of children aged 13 from 19 schools near the city boundary, 13 in the intermediate districts, and 14 in the poorest neighbourhoods, were investigated, the result being shown in percentages in the accompanying table :—

It would appear that in each of the columns the vision is better amongst the children attending the well-lighted schools than in those in which the lighting is less satisfactory, the columns to which special attention should be drawn being those headed "vision excellent" and "both eyes defective." The "vision excellent" column refers to those whose vision is normal, the "good or fair vision" column to those whose vision is not worse than six-ninths for one eye and six-twelfths for the other. Dr. Hope considers that the differences in the percentages in the various columns are sufficiently large to show that there is a relationship between the lighting of the school and the vision of the children. There is also to be explained the fact that, with one exception, the girls' eyesight is distinctly worse throughout than that of the boys, and in that exception the numbers investigated are not sufficiently large to exclude the margin of error. Dr. Hope points out that there is one most important factor—namely, sewing—which operates in the case of the girls, but not in the case of the boys, and which is probably the cause of this greater frequency of defective vision and diminution of normal vision. "This," he writes, "which is the most likely of any item in the school curriculum to affect eyesight, is often carried out under the most disadvan-

Schools.	Number Examined.	Vision Excellent.	Vision Fair or Good.	One Eye Defective.	Both Eyes Defective.
Outskirt Schools—					
Boys	466	53·43	27·90	4·72	13·95
Girls	479	42·80	38·00	5·84	13·36
Intermediate Schools—					
Boys	607	49·92	27·02	7·90	15·16
Girls	585	42·40	28·20	9·40	20·00
Central Schools—					
Boys	567	28·75	39·50	7·41	24·34
Girls	511	24·46	33·86	11·15	30·53

"From this," writes Dr. E. W. Hope, M.O.H., "it would appear that the vision becomes progressively worse as one goes from the outlying districts to the centre of the city. How much of the defective vision in the centre of the city is due to the want of open spaces and to the need for use of the eyesight for distance, and how much of it is due to some hereditary visual defect, or to social conditions or other factors, it is difficult to say. Probably the question of nourishment is an important element."

The table on the next page shows the relationship between the lighting of certain schools and the vision of the children attending them.

tageous conditions of lighting. The stitches under the best conditions are difficult to see, but when sewing is undertaken in classrooms with defective lighting, in rooms where the lighting generally is good, but comes from the back of the children, or on dark afternoons when sometimes the children have to do needlework without the aid of, or with an insufficient amount of artificial light, a condition of eyestrain is produced which cannot be otherwise than harmful. It is very important that teachers should receive definite instructions to cancel needlework on dark days, and that they should be able to take these lessons when more suitable conditions of lighting arise."

There is a general concensus of opinion that defective eyesight is partly attributable to eyestrain whilst the children are in the infants' departments, and Dr. Hope thinks it would be desirable if sewing could be abolished altogether under the age of 7. He further urges that there is not enough discrimination during sewing lessons between children whose eyesight has been found to be satisfactory and those with serious defects, these latter children being expected to come up to the general standard of the class—a result only to be obtained at the risk of serious eyestrain. Now that each department in Liverpool schools has an eyesight register, with the vision of each child recorded, he thinks there should be in the future no difficulty whatever in this discrimination.

Schools.	Number Examined.	Vision Excellent.	Vision Fair or Good.	One Eye Defective.	Both Eyes Defective.
OUTSKIRT SCHOOLS—					
Lighting Good					
Boys	316	54·43	27·85	4·75	12·97
Girls	321	44·86	36·45	5·61	13·08
Lighting Poor					
Boys	150	51·33	28·00	4·67	16·00
Girls	158	38·61	41·14	6·33	13·92
INTERMEDIATE SCHOOLS—					
Lighting Good					
Boys	394	50·76	27·16	8·63	13·45
Girls	396	48·23	23·99	9·34	18·44
Lighting Poor					
Boys	213	48·36	26·76	6·57	18·31
Girls	189	30·16	37·04	9·52	23·28

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

There are not many items in this section. Next month there will be available the papers read at the Convention of the American Illuminating Engineering Society. There are several contributions on **Technical Photometry.** R. F. PIERCE presents some charts involving graphical calculations for interior lighting. PROF. L. WEBER (*Z.f.B.*, Sept. 10) gives a graphical method of summing up the light flux from a polar curve of light distribution.

Among the more purely scientific contributions we may note that of T. C. PORTER on flicker (*Proc.* Roy. Soc., June). An article in *Elektrotechnik und Maschinenbau* (Sept. 1) gives a large number of references in chronological order to work on photo-electric effects. While this work has a somewhat remote bearing on illuminating engineering at the moment it may eventually lead to the development of some simple form of "physical photometer."

W. BASSETT JONES makes some interesting remarks on architectural effects and lighting. He shows how the tendency of some systems (especially indirect lighting) is to invert the ordinary shadows received from daylight. To overcome this a careful study of the amount of light allotted to walls and ceiling is necessary; it is also possible to mitigate unfamiliar lighting effects by the use of suitable colour tones. In *Licht und Lampe* (Aug. 15) there is an interesting account of a collection of old forms of lamps somewhat similar to that possessed by Mr. Johnston and described in our last numbers.

ELECTRIC LIGHTING.

Most of the articles call for little comment. Perhaps the most interesting is the account of the **Mercury-Cadmium Lamps** devised by WOLFKE (*E.T.Z.*, Sept. 5). This is noticed elsewhere in this issue. By the addition of cadmium a white light and an improved efficiency are said to be obtained. Another item of interest is the account of the lighting of Randolph Street, Chicago, by quartz tube mercury vapour lamps fixed to the walls of the houses.

There is also an announcement of a method, due to Dr. Cooper Hewitt, of etching the surfaces of lamp bulbs with acid so as to produce fine prismatic lines. These scatter the rays effectually, and are said to absorb very little light. By this process the distribution of light from the lamp is altered, more light being cast in a downward direction.

GAS, OIL, AND ACETYLENE LIGHTING.

A paper by S. B. LANGLANDS receives notice in the gas journals. The paper contains some interesting practical hints on the maintenance of street gas lamps, and gave rise to a good discussion. The desirability of automatic control by pressure and clockwork came up for discussion.

In the German press we note MAUL'S discussion on the treatment of consumers, methods of attracting custom, rebates, &c., while A. MÜLLER (*J.f.G.*, Aug. 31) makes an interesting announcement regarding a new **Museum for Illumination,** Heating, and Water Appliances shortly to be organized in Berlin.

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CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. u. Masch.—Elektrotechnik und Maschinenbau.
G. W.—*Gas World.*
J. f. G.—*Journal für Gasbeleuchtung.*
J. G. L.—*Journal of Gaslighting.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

"The Attraction of Custom."

This is the title of a well got-up little pamphlet issued by the **Union Electric Co., Ltd.** (Park Street, Southwark, London, S.E.). Excello arc lamps, it would seem, are taking the place of the old apprentice cry "What d'ye lack?" The value of a bright and attractive method of illumination, in order to attract custom, is recognized all over London. The booklet contains photographs of a number of Excello installations, including a night view of the Palladium Theatre and the well-known Electric Avenue, Brixton. These are taken entirely by the light of the actual lamps shown in the pictures. The illustration shows an artistic snap-shot night-view, which occurs on the front page of the leaflet.

A second publication by the same company, 'Daylight at Night by Electricity,' consists in a reproduction of the series of articles recently published in

Electrical Industries by Mr. Justus Eck, and the correspondence with Mr. Willcox that followed.

Shipwrecked Lamps.

The following piece of information sent us by the British Thomson-Houston Co., Ltd., affords remarkable evidence of the durability of the Mazda drawn wire lamp.

Salvage operations on the sunken P. & O. liner "Oceana" resulted in the recovery, amongst other things, of cases containing 600 Mazda lamps. On examination it was found that of five hundred 25 watt 100 volt lamps twenty-two, or 4·4 per cent, were broken, and of one hundred 25 watt 55 volt lamps only two, or 2 per cent, were broken. The remainder were returned to Rugby in perfect condition.

Considering the rough treatment which the lamp cases must have received, the proportion of breakage is remarkably small.

The Moore Light in England.

Although little known in England as yet, the Moore light has made considerable headway in the United States, and more recently in Germany also. As will be seen from an article appearing on p. 465 in this number, a company—**The General Moore Light Co.**—is now being formed in this country. The address of the company is 19, St. Dunstan's Hill, London, E.C.

A Record Lighting Installation.

We are given to understand that the General Electric Co., Ltd., have recently supplied the Dundee Corporation with 88 "Angold" magazine flame arc lamps, all of which were required for replacing the old open type arcs hitherto used for street lighting in that town.

The Nonpareil Ventilating Gas Sun-Burner.

An interesting form of gas lamp has been put on the market by **Messrs. J. Milne & Son, Ltd.** (54, Farringdon Road, E.C.), the "Nonpareil" sun-burner, which is illustrated in the adjacent figure. consists in a ring of inverted burners which are stated to give a total light o 1,200 c.-p., and a consumption of only 27 c.-p. per cubic foot.

The use of this lamp is said to promote good ventilation. It is mentioned that at the Ramsgate Pavilion visitors in the

body of the hall are allowed to smoke since this lamp was installed—which they were formerly not allowed to do because the smoke collected and obscured the view of the stage. From an illuminating engineering standpoint the fact of the lamps being placed high up out of the direct range of sight should also be an advantage.

It will be recalled that before the days of the incandescent mantle burners of the Wenham regenerative type were often employed, not only because of their comparatively high candle-power and good downward distribution, but because the upward draught of air induced was useful for ventilating purposes. It will be seen that the present arrangement

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Holophane and Holophane-Benjamin Reflectors.

A new list (G 1586) issued by the **General Electric Co., Ltd.** (67, Queen Victoria Street, London, E.C.), contains particulars of an up-to-date series of HOLOPHANE glassware. All the latest "Stiletto" types are reproduced, and there are several new items.

The first of these is a semi-indirect lighting fitting utilizing an inverted prismatic bowl; the arrangement is specially advantageous for indirect lighting, since the loss in absorption by the prisms is exceedingly small, and yet a very uniform and soft illumination is obtained. The second novelty is the Holophane Uniflux Reflector. This is particularly serviceable for producing an even illumination over large flat areas, such as pictures, placards, facias, blackboards, &c.

Other items include the Holophane Unit for Billiard Table lighting and the small motor-car or carriage reflector for ceiling use.

The catalogue concludes with an account of the Holophane Benjamin metal reflectors. These are available in five distinct types, each having its respective curves of light distribution, namely, extra extensive, extensive, intensive, focussing, and parabolic varieties. The parabolic angle type are specially useful for lighting large vertical surfaces. These reflectors are very well adapted for factory lighting.

The General Post Office has again awarded the contract for supplying electric lamps during the current year to the Osram Lamp Works. Osram wire drawn lamps are also now a feature of the lighting at the National Sporting Club.

Indirect Lighting of a Publishing House.

The Curtis Publishing Co. of Philadelphia, the largest publishing house in the United States, recently lighted their new thirteen-storey building on the "Eye-Rest" system, which is being developed by the British Thomson Houston Co. in England. The method was adopted by the Curtis Publishing Co. after trials with five other systems. The figure shows the use of inverted X-Ray reflectors for the purpose of producing a diffused light from the ceiling.

The account of the lighting of the Pabst Theatre in our last number provided an interesting example of the system. We may mention that the British Thomson Houston Company are sole agents for the X-Ray reflectors in this country.

A special claim is made for the high efficiency of the form of reflector employed. It is made in one piece of silvered glass with spiral and vertical corrugations so as to remove all signs of streakiness, the silvering being protected by several coats of elastic enamel.

New Benjamin (Electric) Catalogue.

We have been favoured with a copy of the new catalogue of **Benjamin Electric, Limited** (117, Victoria Street, S.W.), which is divided into six sections as follows: (1) Lighting Specialities, (2) Factory and Outdoor Lighting, (3) Office and Indoor Lighting, (4) Shop Window, Show Case, and Picture Lighting, (5) Colour Matching and Light Measuring Apparatus, (6) Glass Reflectors and Globes, (7) Accessories.

In the Lighting Section particulars are given of the well-known wireless clusters, Holophane Benjamin steel reflectors, and indirect lighting fixtures.

Perhaps the most interesting section of the catalogue is No. 5. The "Daylight" unit we have previously described. It is equipped with a special scheme converting the light from metallic filament lamps to give the same spectrum as daylight, and is therefore invaluable for work in which accurate colour matching is needed, *e.g.*, in textile mills, dyeing works, &c.

The "Lightometer" is a new form of photometer invented by Mr. Haydn T. Harrison. It is stated to give a range from .001 up to 10 foot-candles. We postpone further description of this ingenious little instrument until our next number.

Opalux and Veluria Glassware.

We understand that **The British Thomson-Houston Co.** are shortly placing on the market two new patterns of glassware, which will be known as "Opalux" and "Veluria." These reflectors are made in several forms to give varying distributions of light, are extremely beautiful in appearance, both when lighted and unlighted, and are highly efficient.

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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

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EDITORIAL.

The Sixth Annual Convention of the Illuminating Engineering Society in the United States.

AT Niagara this year the American Illuminating Engineering Society held its Sixth Annual Convention and, as usual, the papers contained much interesting matter. The Report of the Committee on Progress follows fairly familiar lines, a serviceable summary of developments in illuminants and general illuminating engineering being given. This report does not call for any detailed comment.

The Report of the Committee on Nomenclature and Standards is divided into two sections, the first dealing with international relations, the second containing some additional proposed definitions of terms used in illuminating engineering.

It is gratifying to find that reference is made to the resolution passed at the meeting of the International Electrotechnical Commission at Turin, recommending that the national committees of that commission should, in matters concerning illumination and its nomenclature, co-operate with national societies having to do especially with such matters. But it might perhaps have been added that this resolution was proposed by the writer, representing the British Illuminating Engineering Society, in which he was ably supported by Drs. Sharp and Kennelly.

We also think that the Report might well have contained some reference to the important resolution passed unanimously at the International Electrical Congress of Turin, sanctioning the step taken by the British Illuminating Engineering Society to form an International Commission on Illumination. This, it may be remarked, is the *only* proposal with regard to international co-operation in matters of illumination

which has received the recognition of an international congress.

The step apparently contemplated by the American Illuminating Engineering Society of extending the membership and functions of the Zürich International Photometric Commission deserves to be closely watched. We are anxious to ascertain more clearly what would be the outcome of this step, and how far it is designed to assist and to be preparatory to the formation of the desired International Commission which we have in view, and for which the cordial co-operation of our friends in the United States has been promised.

Some interesting papers on photometry and the reflection and diffusion of light were also read at the Convention. Special attention may be drawn to the suggestive paper by Mr. C. E. Ferree, who raises some interesting points in connexion with the effect of artificial light in causing fatigue.

There is reason to believe that various conditions occurring with artificial light are apt to be trying to the eyes and cause fatigue; brilliant lights, in the direct range of sight, causing glare, are particularly liable to do so. Mr. Ferree, for instance, found that a progressive decrease in acuteness of vision was observed during three to four hours in a room lighted artificially, but did not occur by daylight, and he ascribed this mainly to the influence of glare. On the other hand, further investigation seems necessary in order to show how far such effects are due to artificial light in general, and how far to defects in the arrangement of lamps. Our chief need seems to be some simple physiological test for fatigue. If the medical profession could provide us with a simple device, enabling us to recognize at once when a system of illumination was causing visual fatigue, the task of deciding what conditions ought to be avoided would be considerably lightened.

We may take this occasion of again referring to the valuable piece of work accomplished by the Illuminating Engineering Society in the United States, on which we should like to congratulate that Society, namely, the publication of a simple 'Primer on Illumination.'

We hope to be able to present very shortly, in a form convenient for those in this country, a summary of these simple and fundamental rules of good illumination. The educational campaign for better lighting that has been conducted during the last few years in this country is already creating a demand for concise information on these points. This demand it will be the function of the illuminating engineering movement to satisfy.

The First Annual Meeting of the British Commercial Gas Association.

On pages 499–501 in this number we give an account of the First Annual Meeting of the British Commercial Gas Association, at which the writer had the privilege of being present. The organization of this new Association marks a great step in the progress of the gas industry. It also comes at an opportune moment, seeing that the next year will be marked by special centenary celebrations of the introduction of gas lighting in this country. The Association is specially fortunate in having as its first President Mr. Corbet-Woodall, who enjoys the unique distinction of being simultaneously President of the Institution of Gas Engineers and the Society of British Gas Industries, as well as Governor of the Gas light and Coke Company. We may add that it has also been fortunate in the able and genial Chairman of the Executive Committee, Mr. F. W. Goodenough.

Our readers are well aware that it is not our principle to favour any one illuminant. Yet we cannot help congratulating the gas industry on the step they have taken. We firmly

believe that the movement, if judiciously guided, besides assisting gas lighting, will be of benefit to the lighting industry as a whole.

For the first time there is in existence an association in which all those connected with gas—those responsible for its production, and those interested in its sale and in the development of heating and lighting appliances—will work together. To get these various sections of the industry to work hand in hand is a feat which surely required for its accomplishment the exercise of a good deal of diplomacy.

The main intention of the Association is to undertake publicity, and here the advantage of pursuing a common policy throughout the entire country is unmistakable. By this means it should be possible to avoid the misleading and conflicting statements which have discredited the lighting industries in the past. The Association has also on its programme the supervision of showrooms and exhibitions, and the promotion of a central laboratory for testing apparatus. We note that an exhibition is proposed to be held at Shepherd's Bush next year. It is stated that this will be organized on entirely novel lines, the object being not to display a heterogeneous collection of appliances, but to devise a concerted scheme for illustrating the applications of gas in general. Thus it is suggested that various types of shops, model laundries, hospitals, nurseries, &c., will be equipped and lighted on the most up-to-date lines.

When reviewing the Electrical Exhibition held at Olympia last year, we frankly expressed our opinion that a co-operative scheme of this kind would have given much better results than the rather chaotically arranged displays of individual exhibitors. It is interesting to observe that the gas industry already appreciates this point, and we hope that the next Electrical Exhibition will also be conducted on more enterprising lines.

One of the most pleasing features in the proceedings at Manchester was the manner in which all the speakers disclaimed any desire to attack rival systems of lighting.

We cannot do better than quote from the paper by Mr. H. J. Yates on the 'Aims and Claims' of the Association. He said:—

"We shall attack no man and no industry; our task is not to make attacks but to repel them. We only need to spread the truth about gas and that truth will carry conviction with it."

We rejoice to think that the time is coming when there will be a general understanding in the lighting industry that mutual controversy and attack is not worth while, that every illuminant has its proper place and sphere of action, and that it is far better to unite in pressing the claims of good illumination on the general public than to neutralize each other's efforts by destructive criticism.

Meantime, while appreciating the value of the British Commercial Gas Association, both to the gas industry and to the general public, we say quite frankly that we should like to see a similarly powerful organization promoted in the electrical industry. It is common knowledge that electric lighting has suffered by the conflicting statements and policy pursued by its representatives; and here, too, there is need for some form of intelligent co-operation.

Modern Show-Window Lighting.

On pages 404-405 in this number will be found an illustrated article dealing with modern shop window lighting. The examples quoted are particularly interesting for two reasons. *Firstly*, the fact of the windows being kept dressed and lighted up till eleven o'clock at night as an advertisement, and *secondly*, the use of concealed lights for illuminating the window on the same principle as is used on the stage. There is no question but that

the windows of a shop form one of its most valuable methods of advertising, and it is clearly good policy to make use of them for a maximum period of time. We anticipate, therefore, that the method of keeping the windows alight after the trade of the day has been concluded will become much more general. It is common knowledge that a show window when well lighted appears more attractive at night, and stands out from its surroundings better than during the day. Good artificial illumination is therefore a most potent means of attracting custom.

On the Continent and in the United States this system has been quite extensively used, in some cases time-switches being installed which enable the lighting to be turned off automatically at a prescribed hour.

But the point which we should like to emphasize specially is the recognition that in high-class trade shop-windows should be lighted by concealed or well-screened lamps which throw their light on the objects to be viewed and not in the customer's eyes. In the West-End of London one finds that this method is now very generally practised. The windows of large shops are carefully dressed with a view to presenting a pleasant picture such as is bound to attract the attention of passers-by. Their effect is inevitably spoilt when bright lights are placed among the articles in the window. Such lights only serve to distract attention from the goods themselves.

One still hears the argument that the display of bright lights is necessary from an advertising standpoint. In the poorer districts this may be so, although even here it is desirable to dissociate the spectacular value of the lights from their purpose in illuminating the goods—in other words, to use one set of powerful lamps, sufficiently high up for advertising purposes. But in the case of shops doing a high-class trade, this method is not only unnecessary but injudicious. It is far better to make the actual means of lighting unobtrusive and to rely on the brightly illuminated contents of the window to attract the notice of passers-by.

Lawn Tennis by Night.

Mr. T. J. Litle, in an article on pages 502–503 in the present number, gives an interesting account of the use of incandescent gaslight to illuminate a tennis court in the United States. It will be recalled that in the early part of last year we gave an account of a somewhat similar installation in the covered courts at Dulwich.* The court described by Mr. Litle is an outdoor one, which no doubt imposes certain limitations in the lighting. It is naturally a somewhat more simple matter to illuminate a court which is protected from the wind and rain, and where it is possible to make special arrangements for the appearance of surroundings and background. In the lawn tennis courts at Dulwich dead black walls and floor and white lines were employed; special frosted glass screens were also inserted below the lamps in order to reduce the intrinsic brilliancy, and we understand that other modifications in the arrangements of lamps, tending still further to eliminate glare, have since been made.

It would appear from the data presented by Mr. Litle that the scheme has proved quite feasible and popular, and that the expense of the artificial lighting is well covered by the extra revenue derived. There seems quite a good field for enterprise in the use of artificial illumination for sport, and we may expect to see other examples of this form of enterprise shortly. These should open up an extensive field for artificial lighting, and form quite an interesting part of the work of the illuminating engineer.

LEON GASTER.

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* *Illum. Eng.*, vol. iv., 1911, p. 273.

Review of Contents of this Issue.

THE first item in the Technical Section is the account of the sixth **Annual Convention of the Illuminating Engineering Society** in the United States. A summary is given of recent progress in high-pressure gas lighting in Europe and in the United States; recent developments in electric lighting include the introduction of high voltage low candle-power tungsten lamps, long-burning arc lamps, and methods of producing artificial daylight. Following this will be found a series of articles dealing with scientific and technical researches. The problems of colour-photometry are discussed, and there are numerous papers dealing with the diffusing qualities of obscured and prismatic glass and the reflecting power of various materials. Several papers treat on the effect of illumination on eyesight. Some experiments recently undertaken show how artificial light tends to fatigue the eyes more than daylight. The question of semi-indirect lighting comes up for treatment, and an attempt is made to consider what the ideal proportions of the direct and indirect constituents should be. Finally, some data are given relating to practical installations in stores and offices.

An important event during the last month was the first Annual Meeting of the **British Commercial Gas Association,** the proceedings at which are summarized on pp. 499–501. This organization is to attend to the publicity of the gas industry, and it is also proposed to organize showrooms and exhibitions, and possibly a central laboratory for testing purposes.

MR. E. J. LITTLE (pp. 502–3) describes the installation of incandescent gas lights for the **artificial illumination of lawn tennis courts** in the United States. He gives figures for the consumption of gas by the lamps, and shows that the expense in lighting is more than covered by the extra revenue derived from play on the courts by night.

The next article deals with **modern electric show-window lighting** (pp. 504-5). The tendency in important stores is now to utilize concealed lamps, the light being thrown on to the goods on the same principle as on the stage. Some photographs are given of windows at Harrod's Stores illuminated by this method. These windows are kept lighted up till eleven o'clock at night. It is recognized that properly lighted show-windows form one of the best possible methods of advertising. In the **St. Louis Public Library** (p. 506) a method of combined general lighting by semi-indirect fittings and local table lamps is employed. This appears to be one of the most satisfactory methods of illuminating a library, neither general nor local illumination alone being invariably correct.

An illustrated article on p. 507 deals with **bead illuminated signs.** Some views of the latest varieties are shown, and some points in their design illustrated. One of the pictures shows a somewhat novel application, namely, the use of a transparency sign on a tramcar at Cardiff. The value of illuminated advertising signs on moving vehicles is likely to receive greater attention in the near future.

At the Crawford Technical Institute, Cork, some simple illumination devices have been devised by Mr. C. E. Greenslade, and are here illustrated and described. Other matters dealt with in this number include a brief reference to the Luchaire Petroleum Standard of Light, the projected Gas Exhibition in 1913, and the methods of lighting employed at the Machinery Exhibition (Olympia).

At the end of this number will be found the usual **Trade Notes** and the **Review of the Technical Press.**

Architecture and Illuminating Engineering.

Some views expressed by Mr. Frank E. Wallis for publication in *The Illuminating Engineer* during his recent visit to London.

(Mr. Frank Wallis is not only one of the best known architects in New York, but he is one who has special opportunities of becoming acquainted with illuminating engineering, having, among other important commissions, designed the NELA [Nat. Elec. Lamp Association] works and laboratories at Cleveland, Ohio, U.S.A.)

THE profession of the architect is a very old one. Illuminating engineering, on the other hand, is amongst the youngest of professions. A few suggestions from one who, while connected primarily with architecture, has also had opportunities of appreciating the value and scope of illuminating engineering may therefore be of interest.

There are certain problems, such as the lighting of offices and factories, in which the object of the light provided is purely utilitarian, and where the illuminating engineer has much good work to do in providing efficient and serviceable conditions of illumination.

But there are higher fields for his activity in connexion with the lighting of buildings of distinction, where æsthetic and architectural considerations must prevail. At the present moment it may be said, quite frankly, that in such work the architectural profession has little use for the illuminating engineer. But this should not be so. The illuminating engineer might be of real service if he understood something of the architect's work and the conditions with which he has to deal. There are many instances in which the illuminating engineer will never carry his point so long as he thinks only of efficiency. He should know something of the history of architecture, and the meaning of the traditions by which the architect is guided. He should understand how to adapt a method of lighting so as to be in harmony with the style of a room, its furniture, and the general scheme of decoration. He should appreciate the fact that the light provided must not only serve to illuminate the table, but to reveal panels, moulding, ornament, and colour. If the illuminating engineer will study these things, his knowledge of the technical possibilities of the various illuminants, of shades and reflectors, &c., should be of great value. I venture to suggest, therefore, that, in the courses of instruction devised for lighting engineers in the near future the study of architecture should play a not inconsiderable part.

In the same way, it may be conceded that some architects do not appreciate sufficiently the aims of illuminating engineering, and it would be well for them, too, to receive more information about illumination, provided this information is presented in a suitable form. There are many instances in which the combined efforts of the architect and the lighting engineer would lead to great results, and for the higher branches of lighting work some form of fusion between the professions seems to be necessary.

I wish your society the success it deserves in its noble and elevating aims, and I hope that it will be instrumental in bringing about closer co-operation on these lines.

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

The Sixth Annual Convention of the American Illuminating Engineering Society.

THIS Convention was held at Niagara Falls during September 16th and 19th, the proceedings being opened by addresses of welcome from Mr. O. E. Dores and Mr. G. F. Nye, respectively presidents of the Board of Trade of Niagara Falls, of Ontario, and New York. The first item on the programme was an address by the President, Mr. V. R. Lansingh on the value of illuminating engineering to society. Following this the usual reports of committees were presented. We refer to the report on standards and nomenclature in the Editorial of this number. Besides a general account of the movement in the United States for devising international nomenclature, the report contains a list of the proposed terms and symbols used in illuminating engineering.

Recent Progress in Gas Lighting.

The report of the committee on progress covers somewhat familiar ground. The most conspicuous advance in gas lighting in the United States has been the extensive introduction of the silk mantle. The inverted mantle has also been rapidly replacing the upright type. The use of high pressure has conspicuously increased abroad, but as yet few and small permanent installations have been made in the United States. There is, however, prospect of great progress shortly.

A feature has been the introduction of a wide range of sizes of burners. There are now on the market inverted and upright types consuming from one to seven cubic feet of gas per hour. Progress has also been made in the standardization of fixtures, and the introduction of more artistic and scientific designs. Among comparatively new applications of gas lighting, due to better and more powerful burners being available, may be mentioned the use of incandescent gas lamps by photographers.

Progress in Electric Lighting.

The most important change in electric incandescent lighting during the past year has been the widespread adoption of the drawn wire tungsten filament. Tungsten wire can now be drawn to a much smaller diameter than has previously been available, and 110 volt 10 watt lamps have been produced; the 15 or 16 watt size, however, is the smallest tungsten lamp in any considerable use as yet. The larger lamps consuming up to 500 watts have been in great demand, and on the Continent 1,000 watt lamps are coming into commercial use. It is stated that such lamps have now the consumption of 0·8 watts per candle (Hefner). At this figure an economic life of 500 hours or more has been repeatedly claimed. There is a good prospect of the size of bulbs of tungsten lamps being still further reduced.

In connexion with arc lamps the chief feature has been the introduction of flame lamps of the long burning type. A lamp with an electrode life of 100 hours has been produced. The

tendency is to use carbons mineralized practically throughout instead of only a core. A three phase arc with three converging carbons has been introduced abroad, and is said to give a powerful and efficient light adaptable for circuits of frequency as low as 25 cycles per second. The Magnetite "Boulevard" arc lamp has been largely used for spectular illumination and the Titanium Carbide arc is also promising. Quartz mercury arc lamps are making good progress, and an interesting development in the form of the Neon Vacuum lamp has made its appearance in France.

Reference is made to the Moore White Light and the use of fluorescent reflectors with the mercury vapour lamp. Special interest attaches to the various devices now on the market for obtaining "artificial daylight."

It is stated that :—

"No device for obtaining daylight values of illumination, sufficient to meet all the requirements of color discrimination has as yet been entirely satisfactory, all of those yet devised being open to criticism on theoretical considerations, though all are undoubtedly capable of great usefulness in meeting the trying conditions of this problem. It is fair to say that they do not vary among themselves more than the different conceptions of 'white light' vary. It would be exceedingly interesting to see what could be done with mantle gas burners properly screened in meeting this requirement. A daylight unit of this character is now being developed with promising results."

General Progress.

Much technical research has been done on the ultra-violet rays ; it now seems to be agreed that these rays should not be prejudicial if reasonable and proper precautions are taken.

There is a strong tendency towards methods of diffusion in illumination with a view to reducing glare. Many experiments have been made in the field of colour photometry, and these researches somewhat favour the use of the flicker instrument for sources of light which differ considerably in hue. Some recent researches on the selenium cells yielded interesting and promising results. In England another attempt has been made to produce a primary standard of light from incandescent platinum, but the experimental difficulties appear to be considerable.

A notable development has been made in the direction of direct and indirect lighting, and the latter, in particular, has made considerable progress. The development of artistic glassware is making considerable strides, and there have also been improvements in metallic reflectors. In street lighting there has been a great development of the so-called "great white way" method of lighting, frequently carried out as the result of private enterprise of Boards of Trade or groups of merchants. Supervision is necessary to keep this method within due bounds, and to insure that the illumination is diffused on scientific and artistic lines.

High-Pressure Gas Lighting in England.

The remarkable development of high-pressure gas in Europe has naturally attracted attention in the States, and at the Convention papers were presented by Mr. F. W. Goodenough (of the Gas Light & Coke Co., London, and Chairman of the Council of the British Illuminating Engineering Society), Herr O. Klatte (Germany), and Mr. R. M. Zeek (United States), also detailing progress in their respective countries.

Mr. F. W. Goodenough's paper contains a very interesting account of the steps and the progress of this system of lighting in England. It appears that the earliest form of high-pressure apparatus was devised by a Belgian gas engineer, M. Greyson de Schodt, of Namur, in the year 1896. In the following year an important compressing apparatus was introduced by Messrs. Keith & Blackman in London, the pressure being still 8 in. ; good work was also done by the late Mr. William Sugg and his firm, who made several important installations, including one on the outer railings of Buckingham Palace. In the meantime various self-intensifying lamps (Scott-Snell, Lucas, &c.) came into use, enabling higher

efficiencies to be obtained than the ordinary high low-pressure gas supply.

The benefit of much higher pressures was still not appreciated, on account of the incomplete development of the type of burner employed at that time. The introduction of the inverted mantle also did not at first appear to favour high-pressure lighting, and it was not until the year 1907, when a new type of inverted burner, utilizing a large percentage of the waste heat from the burner, was introduced by the Keith & Blackman Co., that any great step forward was made. With this lamp a much higher pressure (about 54 in. of water) was used, and it has since been found that even higher pressures are sometimes desirable.

The immediate result of this new system was to double the efficiency of the light. With gas of average calorific and illuminating power as much as 60 candles per cubic foot could be obtained, and Mr. Goodenough suggests that, with the higher illuminating and heating value of the gas prevailing in the United States, as much as 80 candles per cubic foot might, perhaps, be obtained. The reduction in the size of mantle necessary to give a certain candle-power has made it possible to obtain very much more powerful lamps than hitherto, and there has been a general tendency towards the use of these very large units of light—perhaps not entirely desirable from the illuminating engineering standpoint.

The introduction of inverted high-pressure burners has also revolutionized the type of lantern employed, especially for outdoor purposes. The square or hexagon lantern has given place to the suspended globe, as the danger of breakage of glass due to the heat developed is much less. Enamelled steel has also proved better than copper for the metal work.

In the latter section of his paper Mr. Goodenough summarizes the recent spread of high-pressure gas for street lighting in London. The first considerable extensions were in the City of London. The opening of the new thoroughfares of Kingsway and Aldwych provided a good opportunity for the new illuminant, and, somewhat later, at the end of 1908, a considerable impetus was given by the successful lighting of the Franco-British Exhibition. Following this, Fleet Street was illuminated by high-pressure inverted burners (installed and lighted for the first time on Christmas Eve), which were fixed on brackets outside the buildings. Still more recently, as is well known, a large part of the West End of London has been lighted in this way.

Long before high-pressure gas came into general use for public lighting there were quite a number of private installations in factories, especially in laundries and iron-works, &c., where the good heating efficiency of high-pressure gas was advantageous.

During the last few years, however, there has been a great development in what is termed "parade lighting" systems. A few companies started the movement by making arrangements to supply a number of shop-keepers in one block of buildings with high-pressure gas, thus relieving the consumer from the necessity of installing a private compressing plant of his own. The maintenance of the lamps is in the hands of the gas company, and an inclusive fixed price per annum is agreed upon. Such installations have rapidly multiplied. The Tottenham and Edmonton Gas Co., which was one of the first companies to go into this on an extensive scale, has now some 12,000 miles of mains entirely devoted to this purpose, and the South Metropolitan Gas Co. has recently extended their system to 14 miles. The length of high-pressure mains for this purpose seems destined to make considerable progress, and to do away with the inconvenience of individual compressors. There are still a few problems to be solved, such as the provision of satisfactory meters, but it is hoped that these requirements will be met before long.

At the present moment it is calculated that in London and its vicinity, several 12,000 lamps of an average candle-power of 1,000, are now in use. The majority of these have been fitted up within the past two years.

High-Pressure Gas Lighting in Germany and The United States.

The short paper by Herr Oscar Klatte dealt with the progress of high-pressure gas lighting in Germany. One of the most remarkable developments has been the suspension of high-pressure lamps on wires across the streets. In the case of streets which were lined with trees, suspension over the centre of the roadway, by means of a pole with a long projecting arm and a wire suspension, has proved very popular. Lamps having one, three, four, or five mantles, and varying in candle-power from 1,000 to 4,000, have been installed.

An indication of the growth of this form of lighting is found in the city of Berlin. In 1905, about 4 miles were lighted with high-pressure gas, but during the period from 1905 to 1911, 32 miles of high-pressure gas lighting were added, and a further extension of 42 miles is contemplated.

While the use of pressure gas lighting is more or less commonly seen in various parts of the world for street lighting, in Germany it is used, not only for lighting streets, but also for lighting freight stations, amusement parks, and similar enclosed or semi-enclosed spaces where high candle-power units are suitable; and the use of this method of lighting with single units and indirect fixtures is being developed for the illumination of drafting-rooms and schools.

Indications point to a greatly increased development of this method of lighting for all purposes.

Mr. R. P. Zeek briefly described the installation of the six typical installations of high-pressure gas in American cities. These are comparatively small compared with European practice, but there is every reason to suppose that in the near future this form of lighting will play a more important part.

One other paper on gas lighting, by Mr. R. F. Pierce, deserves mention. Particulars are given of the deterioration in the light from gas lighting units, owing to failing of the mantle and the deposit of dust on glassware, &c., were given. The rates of deterioration from different sources at the end of 1,000 hours, taking the average, were found to be as follows: Mantle alone, 2·5 per cent.; burner alone, 10 per cent: total, 15 per cent. The author concludes that, so far as the design of illumination is concerned, there is no substantial difference between the performance of gas and electric units, and the quantity of illumination required and obtained by the one will be equally suitable to the other.

Photometry and Research.

There are quite a number of papers within this section; that by Dr. E. P. Hyde, entitled 'Methods of Research,' is of a somewhat philosophical type, the author's apparent intention being to analyze the conditions favourable to research work in general.

Dr. H. E. Ives summarizes the present position in heterochromatic photometry. After considering various methods of comparing sources of light which differ in colour (equality of brightness, acuteness of vision, flicker, &c.), he comes to the conclusion that the use of the flicker photometer is probably the best method. It is also essential to work with a fairly high illumination of, say, 25 lux (2½ foot-candles), and with a photometric field consisting of a central portion subtending about 2 degrees at the eye, surrounded by a region subtending about 25 degrees. The observer should have approximately a normal colour vision.

On the whole, it seems best to make accurate comparisons with a certain number of practised observers whose vision is known to be normal, and to relieve the average observer from colour difficulties as far as possible. Dr. Ives therefore favours a method of sending out secondary standards for use with lights of various colours, the tint required being obtained by the use of a slightly coloured glass.

In conclusion, some remarks are made on the standard of light. On theoretical grounds there seems reason to advocate a standard which can be checked by measuring radiant energy. This may be done in either of two equivalent ways. *First*, a monochromatic radiation of known luminous efficiency (as determined from the

average luminosity curve) may be measured, both in light and energy units. The green mercury radiation is very well suited for such a measurement. *Second,* any radiation may be measured through an absorbing screen, which transmits the various spectral radiations exactly in proportion to their luminous efficiency.

Reflecting and Diffusing Power.

MR. P. G. NUTTING describes a most ingenious method of measuring the reflected power of surfaces. In general, this can only be done by somewhat tedious and indirect processes, since the value of the reflecting power depends on the angle at which it is illuminated and observed. Mr. Nutting makes use of the following principle. If there are two parallel infinite planes, one of which is a diffuse illuminator, and the other the surface of which the reflecting power is to be determined, the relative brightness of these two planes is the reflecting power of the known luminous plane. Thus, if the reflecting power of the known luminous plane is 100 per cent, both planes would be equally right. One plane may be made luminous by transmitted light, provided the light is well diffused so that the surface obeys a cosine law.

The diffusing screen in Mr. Nutting's instrument is made of dense milk glass or porcelain, rough-ground on both sides. Naturally, it is impossible to secure infinite planes, but a size large enough for practical purposes (apparently about half a square foot) may easily be obtained. The brightness of the two planes is compared by means of a polarizing device.

A detailed analysis of the reflected powers of painted walls is furnished by MR. C. W. JORDAN. He gives polar curves and micro-photographs of a number of surfaces, showing how the light varies at different angles, and also a spectrophotometric analysis of certain paints.

MR. P. G. NUTTING also contributes a theoretical discussion on 'The Nature of the Diffusion and Transmission of Light.' One interesting conclusion that he reaches is, that surfaces which consist of masses of transparent crystals may be quite good reflectors. The theoretical observation of light need not be more than about 15 per cent.

MR. E. L. ELLIOT points out the need for some definition of diffusing power. He suggests that a completely diffusing globe should appear equally bright all over. He proposes therefore to measure the ratio of brightness of the least and most brilliant portions of such surfaces, and to regard this ratio as the co-efficient of diffusion. For example, if the brightest part of a globe were twice as brilliant as the dullest portion, the diffusing power would be said to be 50 per cent. Globes of opal, alabaster, "alba," and prismatic glass differ quite noticeably in this respect.

One other paper which may, perhaps, be noticed as coming within this section is that of MR. F. A. BENFORD, which consists in an exhaustive mathematical and graphical investigation of various problems in illuminating engineering calculations; a number of charts are given, showing how to calculate the illumination of inclined illuminated planes.

Illumination and Eyesight.

Next in order we may take several papers describing tests on the effect of illumination on the eye. DR. P. W. COBB shows how acuteness of vision is affected by the brightness of the illuminated object, and by contrast with the surroundings. The curious fact is noticed that surrounding the test object by a surface almost as bright as them tends towards improvement. In fact, under certain circumstances, the eye can see more clearly when a large amount of light falls into it from outside the object seen. A somewhat different line of investigation is followed by MR. C. E. FERREE, who has tried to analyze the conditions that produce discomfort. He has carried out comparative tests by direct artificial light and daylight, and finds that by artificial illumination acuteness of vision falls off progressively in the course of about three hours, whereas by daylight no appreciable change was noticed. The chief defect in artificial light, leading to this fatigue, seems

to be connected with the presence of bright lights in the field of vision. It is also noticeable that the extreme regions of the retina are more sensitive to such influences than the central area; in other words, bright lights seen "out of the tail of the eye" are particularly objectionable.

A comparison between natural and artificial light is undertaken by Dr. M. Luckiesh. A number of comparative tests on the distribution of natural and artificial light are given, and it is interesting to notice that the resemblance between daylight conditions and those prevailing by direct artificial illumination are very similar. There is, however, a great difference in the ratio of upward and downward light in the two cases.

Some interesting particulars of the ratios of brightness of adjacent objects by artificial light and in the daytime are given as follows:—

$$\frac{\text{Sun at zenith}}{\text{Blue sky}} = 300{,}000$$

$$\frac{\text{Sun at 5 deg.}}{\text{Blue sky}} = 1{,}000$$

$$\frac{\text{Sun at zenith}}{\text{Bright cloud}} = 30{,}000$$

$$\frac{\text{Bright cloud}}{\text{Blue sky}} = 10$$

$$\frac{\text{Tungsten filament}}{\text{Bright ceiling}} = 150{,}000$$

$$\frac{\text{Frosted tungsten lamp}}{\text{Bright ceiling}} = 500$$

$$\frac{\text{Overcast sky}}{\text{Brightest object in room}} = 10$$

It will be recalled that Weber has recommended that this ratio ought, preferably, not to exceed 100, in order that glare may be avoided.

General Illuminating Engineering.

Turning next to papers on general lighting problems, we may take first, that by Mr. E. L. Elliot on 'The Determination of Luminous Efficiency.' Luminous efficiency, as applied to interior lighting, is a somewhat uncertain phrase. It has sometimes been used to denote the percentage of the total light falling on the working plane. But horizontal illumination is not always the most effective. For example, lighting is often carried out on sloping desks. Mr. Elliot therefore proposes that one should make a measurement of the total amount of light reaching an object from points above the plane in which the object is situated. He has tried a special instrument for determining this quantity.

Mr. T. W. Rolph deals with the principles of indirect and semi-indirect lighting. Assuming that semi-indirect lighting is taken as fulfilling the most general requirements in practical lighting, two questions arise: (1) what proportion of the light should be direct; and (2) what should be the photometric distribution of the light comprising the indirect component. The first question is settled mainly by the amount of direct light that can be permitted without causing inconvenient reflection off more or less shiny paper. A number of experiments were made by three different observers and with different qualities of paper, and the conclusion reached that regular reflection only becomes appreciable if the percentage of direct illumination exceeds 15 per cent. A small amount of direct light is actually beneficial in order to give more definite shade. Another point to be noted is, that semi-indirect fittings should not cause glare, and it was recommended that the intrinsic brilliancy of the diffusing surface round the lamp must not exceed that of the ceiling. This is also beneficial with a view to avoiding inconvenient specular reflection.

The next question to be studied was the desirable distribution of light on the ceiling of a room. The white ceilings tested possessed a reflecting power of from 73 to 78 per cent. In order to deter-

mine the effect on various portions of the reflected light, the ceiling was divided into a number of zones, the adjacent parts being blocked out with black flannel. The distribution of light in the room due to each of these zones was determined separately. As a result of these considerations the authors present what they consider the ideal polar curve of light distribution for semi-indirect units. To obtain the highest efficiency and good diffusion, the illumination on the ceiling should be practically uniform from 180 deg. (vertically overhead) to 140 deg., and should gradually fade away at angles lower than 105 deg. The light beyond this angle is liable to strike the walls, and the intensity should therefore be fairly low. It is pointed out that, assuming the desirable direct component in the *illumination* to be 15 per cent, the actual percentage of directly transmitted light from the source works out at about 6 per cent. These requirements are met by the form of curve suggested by the authors.

Messrs. C. L. Law and A. L. Powell have collected some interesting data from over 800 small shops in New York and around. For such shops elaborate recommendations are out of place. What is needed is a set of approximate rules by which the main essentials of good lighting can be secured. Photographs were taken in many of the shops visited, and data are presented for the illumination.

Such shops may be grouped as follows :—

(1) Those which demand equal illumination on the side-wall shelves and on the counters, such as bakeries, china, delicatessen, drug and grocery stores, and meat markets. If a store is of medium width, two rows of lamps with intensive reflectors, or one row of multi-light fixtures with wide arms, will be satisfactory ; if narrow, one row of lamps with extensive reflectors.

(2) Those which demand good illumination on the counters, with a smaller amount of light flux on the side walls, such as cigar, dry goods, fish, haberdashery, jewellery, pawnbroker, and stationery stores, rows of relatively small lamps with intensive reflectors, providing localized illumination with reference to the counters, serve well.

(3) Those stores which demand the highest intensity on the wall surface and a low general illumination. Art, music, hardware, and paint stores fall in this class. Two rows of relatively small lamps, with intensive reflectors located close to the wall, or, if very narrow, one row of lamps with distributing reflectors.

(4) Those which demand diffuse general illumination. In this class are clothing, confectionery, florist, furniture, novelty, millinery, tailor, shoe, trunks and leather, wine and liquor stores, and restaurants. Decorative fixtures and equipment, or simple units arranged for even illumination on the theoretical working plane, may be provided.

(5) Those stores in which localized lighting is needed, as in barber shops, hairdressing and manicuring establishments.

The Table on next page gives a summary of the data collected.

The report of the Illumination Committee of the Association of Iron and Steel Electrical Engineers is concerned mainly with methods of presenting data about illuminants. For example :

It is recommended by the Committee (1) that, in judging lamp size, the mean lower hemispherical candle-power or the downward lumens be used, in conjunction with at least the average inherent deterioration of the lamp during the life or trim. The liability of the lamp to acquire deterioration can be judged on the basis of the mechanical construction until acquired deterioration data is available.

(2) That the illumination curve for the height at which the lamp must be used be employed to check the evenness of the illumination from the lamp and the utilization of the light.

(3) That manufacturers be encouraged to submit candle-power distribution, illumination, and deterioration curves on illuminants.

(4) The manufacturers be urged to

submit constants or spacing tables for the use of lamps.

(5) That illumination tests be encouraged by the members for the purpose of obtaining data on deterioration.

(6) That the Association co-operate with the Illuminating Engineering Society by encouraging such tests, and by presenting from time to time for discussion and solution the problems of the members.

ILLUMINATION DATA FOR SHOPS (C. L. LAW AND A. L. POWELL).

Type of Stores.	No. investigated.	Watts per square foot. Max.	Min.	Aver.	Recommended.
Art stores	14	2·02	0·40	1·01	1·3
Bakeries	29	1·74	0·25	0·82	0·8
Barber	34	2·62	0·51	1·23	—
Cigar	29	2·00	0·39	1·45	1·4
Clothing	78	3·12	0·27	1·37	1·5
Confectionery	30	2·38	0·26	0·97	1·0
Delicatessen	29	3·36	0·37	1·11	1·1
Drug	24	1·85	0·43	1·01	1·2
Dry Goods	28	2·50	0·69	1·26	1·0
Florist	13	1·59	0·48	1·07	1·1
Grocery	53	2·73	0·30	0·98	1·0
Haberdashery	23	4·95	0·60	1·43	1·7
Jewellery	26	4·38	0·50	1·54	1·6
Meat Markets	32	2·42	0·40	0·91	0·9
Millinery	27	4·16	0·30	1·28	1·3
Music	11	1·85	0·60	1·05	1·1
Restaurant	27	3·20	0·42	1·08	1·1
Shoe	31	1·87	0·36	0·98	1·0
Stationery	35	2·40	0·45	1·02	1·0
Wines and Liquors	25	2·89	0·40	1·20	1·0

It may be noted that in both the years 1911 and 1912 the Association has devoted a special day to illumination, and there is no doubt that the information derived has been of considerable assistance.

The last paper to be noticed is that of MR. W. D'A. RYAN, on 'The Lighting of the Buffalo General Electric Building.' Complete plans showing the arrangements of points and illumination obtained throughout the buildings are given.

It may be noted that semi-indirect lighting is largely used, and the fittings were specially designed. The outside of the building is illuminated by 6·6-amp. luminous arc lamps, the rays of which, falling on the white building, are stated to make a pleasant contrast with the yellower light of the tungsten lamps seen though the windows. Three hundred feet above the street in the tower there are three searchlight projectors on a revolving platform, by which flashes of various colours can be obtained. The watts per square foot for the entire building average 1·4. The total area is 76,800 sq. ft., and the connected load 108 k.w. The illumination is seldom less than 4, or more than 6 foot-candles, except in the drawing office where it is somewhat higher.

The Exhibition of Portable Acetylene Lamps.

The "Office Central de l'Acétylène" has organised an exhibition of portable acetylene apparatus which is to take place on December 12th to 14th, 1912. A special section will be devoted to apparatus of interest to railway companies. Cards of invitation will be issued to those interested in the exhibition, and applications to show apparatus will be entertained up to November 20th. All communications relating to this exhibition should be addressed to the "Office Central de l'Acétylène," 104, Boulevard de Clichy, Paris.

British Commercial Gas Association.

FIRST ANNUAL MEETING.

THE FIRST ANNUAL GENERAL MEETING of the British Commercial Gas Association, opened on Tuesday, October 8th. Space does not permit us to give a very detailed account of the proceedings, for which readers may be referred to the reports published in *The Gas World* and in *The Journal of Gas Lighting*.

After addresses of welcome to Manchester and Salford, a resolution was presented to MR. R. G. SHADBOLT, the Past President of the Institution of Gas Engineers, expressing appreciation of his service during the year. This was read by MR. F. W. GOODENOUGH, and MR. SHADBOLT briefly replied.

Inaugural Address.

The first President of the Association, MR. CORBET WOODALL, then rose to deliver an address in which he alluded to the remarkable service which the Association would be able to render to the gas industry.

At this meeting, he said, there were assembled the most comprehensive and representative body of gas men ever brought together for any purpose. The Association marked the beginning of a new policy. Prominent among its aims would be the question of co-operative advertising, but it was also necessary to ensure that customers should receive the best possible value for their purchase, and it was to organize the service of the gas industry yet more completely. The issue of the gas *Bulletin* would serve to illustrate work that the Association was prepared to do. National publicity was complementary to local publicity. The Association, working on general lines, would stimulate progress in other sections of the country. All sections of the public—Government officials, architects, school teachers, and sanitary authorities—ought to be approached.

MR. F. W. GOODENOUGH presented the first annual report. He explained that the Association already received the support of 256 municipal and company undertakings and substantial work in the direction of publicity had already been done. The Association was already returning full value to its supporters.

Value of Unity and Co-operation.

"It is creating among all who enter into its work—all who follow its operations with interest, who read and contribute to its *Bulletin*, who make use of its services and render service to it—a spirit of unity and co-operation, an increased and increasing enthusiasm for progressive methods, and a higher standard of service to the public, which are bound to be of value to the individuals themselves, to the undertakings they serve, and to the industry as a whole.

Moreover, the Association is not merely an instrument of publicity, though—be it said to those who are inclined to regard publicity work as beneath the dignity of the gas profession—advertising, once a blatant business associated principally with quack remedies, is in a rapidly increasing measure becoming an honourable and scientific profession, based upon truth and honesty, and to-day forms an integral part of every progressive business. The Association is also, as its first conference is designed to prove, a valuable organization for the mutual study and discussion of the high politics of commerce, and for the perfecting of profitable public service.

The work of the Association is complementary to that of the Institution of Gas Engineers, and of vital importance to the whole industry. It is no use manufacturing cheaply that which you cannot sell."

MR. ALEXANDER WILSON (Glasgow), MR. KENDRICK (Stretford), and others spoke in the brief discussion that followed, and the report and accounts were adopted.

Defence—not Attack.

Then followed a paper by MR. H. J. YATES on the 'Aims and Claims' of the British Gas Association. Mr. Yates laid stress on the value of using *bona fide* statements of the claims of an

illuminant, and dismissing all misleading contentions. The matter was one which appealed to all concerned in municipal electric management, for they were in a position to hold the balance between gas and electricity, and to recognize the legitimate sphere of each and their respective advantages. "We shall attack no man; and no industry; our task is not to make attacks, but to repel them. We only need to spread the truth about gas, and that truth will carry conviction with it."

Later Mr. Yates added :—

"Our advertising being defensive, and not offensive, will not meddle with electricity where (as in such circumstances would be the case) electricity does not attack gas. Gas and electricity have each its own sphere. There are two classes of people chiefly who are to be addressed by the Association's advertisements—those who are not using gas at all, and those who are not yet using it for all the purposes for which they could with advantage do so. Now this advertising is not going to capture business from the electric department; it is going to create absolutely new business."

It was proposed that the Association would cover and tabulate information of value bearing on the interest, uses, and advantages of gas, in a way which individual local gas authorities and officials could not do. When a local gas undertaking finds itself confronted with a difficult problem it can always apply to the Association for assistance.

Laboratories and Testing Rooms.

It was essential that the undertaking should have a thoroughly able technical man on its staff to deal with such matters. It was also hoped that the Association would presently have available laboratories and testing rooms of its own, so that it could test at first hand new inventions, and place a hall-mark on various kinds of gas apparatus —a hall-mark which would naturally be a valuable indication that the apparatus had been adequately tested. The Association appealed both to those who had to sell gas and those who were concerned with implements and apparatus, and many instances could be quoted in which the general influence of the Association had benefitted local business.

In the discussion which followed, Mrs. Cloudesley Brereton, the editor of the Association's *Bulletin*, laid stress on the importance of having at command full information to be embodied in articles not only in the *Bulletin*, but also in the general press. Mr. H. M. Thornton, speaking as a manufacturer, rejoiced that the day had dawned when the gas engineer and the manufacturer of gas plant and appliances would co-operate together. Mr. Leon Gaster (Editor of *The Illuminating Engineer*) expressed the belief that there was ample room for the development of both gas and electricity. He was glad to see that the recognition was gaining ground that it was a waste of time to attack other systems of lighting; that it was much better to concentrate effort on bringing forward trustworthy evidence of the special uses of an illuminant. He fully believed also that in securing publicity there should be some form of co-operation, so as to avoid presenting to the public contradictory and bewildering statements. The Association would doubtless do much to promote these ends, and if it went about its work in that spirit, it would have his good wishes.

Among others who spoke, Mr. Thomas Glover (Norwich) mentioned some instances of valuable work being secured through general advertisements, and Mr. H. Bloor (Carlisle) laid stress on the need for educating municipal councils in lighting matters.

Mr. S. R. Barrett (Birmingham) urged that one direction in which the Association might be guided is that of educating gas fitters. More and better trained men were needed.

Good Window Displays Essential.

Mr. G. Clarry (Cardiff) read a paper on showrooms in relation to gas supply. He gave an account of the equipment at Cardiff, laying stress on the value of effective window displays. In this connexion he remarked :—

"We find that a regular succession of attractive windows, of original and striking design, will grow to be a subject of interest and remark with the public. It is important that the window should be dressed according to season; and there is no limit to the exercise of ingenuity and taste. The use of plants is specially recommended. A special arrangement, by which the front window was set out as a dining-room—having the table decorated with fresh-cut flowers and fruit—proved an effective advertisement. Incidentally, it was somewhat costly; but the expense was fully justified by the amount of interest it aroused. For winter evenings, an illuminated flashing device, or a lantern screen exhibit, with special subjects, proves an effective display. The adoption of special window and inside displays suited to particular trades in the district, is worthy of attention."

It may also be noted that a specially appointed officer of good organizing capacity would in general be required to deal with the increase in work following these advertising efforts, and in this connexion MR. CLARRY quoted three important "don'ts," namely:—

1. Don't ever understaff.
2. Don't overcrowd your goods.
3. Don't display dead stock.

In the case of small works, in which it may be impossible to set up a showroom a combined display might be made at some central premises in the nearest market town.

"Every showroom would be fully equipped with the latest and best appliances, all of which are to be at the disposal of consumers upon terms which would be either gratuitous or nominal. Expert instructors would be employed in teaching, free of charge, prospective consumers the way to use new appliances and apparatus. Demonstrations to be given by competent lecturers on current subjects of interest to gas consumers. Moving picture displays to appear both in the windows and in the lecture room. Lastly, the entire lighting and heating of every consumer's premises would be taken in hand from the gas works, free of all maintenance charges."

MR. THOMAS CANNING (Newport) remarked that improvement was needed in gas fittings. At present many dozens were considerably inferior to those sent out by the same firms for electric lighting, and he thought there were great possibilities in this direction. MRS. CLOUDESLY BRERETON gave evidence to the same effect. In visiting Harrod's, Selfridge's, and other large establishments, she had been struck by the fact that the fittings shown for gaslighting were decidedly less pleasing than those for electricity.

Hygienic Value of Gas Lighting.

Another matter which was brought prominently forward was the question of the hygienic value of gas lighting. MR. H. H. CREASY gave an account of the campaign carried out in London with a view to interesting doctors and hospitals in heating by gas—a direction in which MR. F. W. GOODENOUGH had done much pioneering work.

Mr. Goodenough pointed out that in order to follow up such a campaign good service was essential.

"It was no use instituting a campaign amongst medical men, or any other class of scientists, unless care was taken that the gas fires were properly fixed, and, when they were fixed, kept in proper order. No amount of publicity or canvassing was any good if it was not backed up by good service, and in the case of gas fires good service meant good fixing and good overhauling."

Subsequently, a lecture on the hygienic aspects of gas in home, school, and workshop was delivered by PROF. VIVIAN B. LEWES, and there was also a paper by MR. A. F. SHELDON on 'The Science of Building Business.'

Playing Tennis at Night by Incandescent Gas Light.

By T. J. Litle, Jun.

Experiments have been conducted over a period of several months to determine whether or not it would be practical to play lawn tennis at night on courts illuminated by Multiflex gas arcs. These experiments have culminated in an installation where four tennis courts are lighted at the Woodbury Country Club, Woodbury, New Jersey, U. S., the gas being supplied by the Public Service Gas Company.

Tennis is becoming so popular in America that it becomes difficult for the average business man to enjoy the game even on Saturdays and holidays, the courts being in such great demand, and it was with the idea of remedying this situation that night tennis was considered.

The lighting of a single court would not be adequate for a country club, because so few of the club members could take advantage of the court during the evening. Moreover, when more than one court is lighted the illumination becomes more economical, as the light over one court contributes to the illumination of the adjoining courts.

The lighting of single private tennis courts, however, is perfectly feasible. A very high illumination is necessary; cheapness is therefore a very important consideration. Excellent results have been obtained with powerful incandescent lamps.

It has been found at Woodbury that the courts are patronized on an average of three hours an evening with all courts filled, and a number on the waiting list. A number of players interviewed declared that they enjoyed night tennis immensely more than day tennis, for the reason that in the cool of the evening they did not become so easily fatigued. From the social standpoint it may also be considered a great success. There are quite a number of automobiles stationed alongside the courts every night watching the game.

The nominal charge of 10 cents per hour per player will more than cover all expense incidental to the operation of the lamps. Thus:—

Cost of operating two courts for one night.

Cost of gas at \$1·00 per mo. 24 lamps (18 cu. ft. per lamp) three hours per night	\$1·29
Maintaining 24 lamps at 50 cents per mo. (\$12·00 for 25 days)	·48
Total for two courts for one night	\$1·77

Revenue from two courts for one night.

8 players, 3 hours at 10 cents per hour ...	\$2·40

When the proposition for supplying gas for night tennis was put up to the Public Service Gas Company they agreed without a moment's hesitation to run over 200 ft. of 3 in. main, realizing that here was a new use for gas which promises to be very popular before the end of the present season.

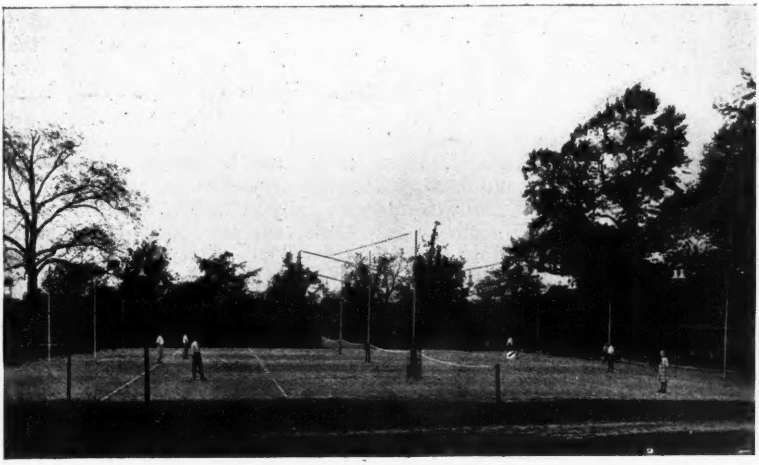
The night photograph shows the remarkably high and uniform illumination obtained by the use of the Multiflex gas arc lamp. In taking the picture it required but one and a half minutes' exposure on a very dark night, by the light of the lamps alone. The installation is designed to include standard material both in lamps and piping. Any pipe shop can turn out the work promptly. The installation shown in the photograph was made in two days, all the pipe being cut in the pipe shop and the poles being assembled and erected on the ground.

It will be noted that with the exception of the pole alongside of the net posts, there are no posts near the side lines, the mast arms extending far out from either side of the central poles taking the place of objectionable side poles. Installations can be made by following the instructions in the accompanying diagram.

As shown, the poles are made up of standard pipe imbeded in concrete, each pole extending 3 ft. below the surface. The gas is taken into the pole 1 ft. below the surface, leaving a 24 in. drop at the base of each pole.

A plug outlet is located at the ground level so that a rubber hose may be inserted for pumping out the drips on each pole. The pipe line is, of course, dripped to the meter, which is located in the basement of the club house about 100 ft. from the court. The posts are painted white to match the white and where the courts are immediately alongside of each other the number of lamps may be greatly reduced as follows:—

1	court	16	lamps	gas	consumption	288	cu. ft.	per hr.
2	"	24	"	"	"	432	"	"
3	"	32	"	"	"	576	"	"
4	"	40	"	"	"	720		"



Tennis Court by Daylight.

The same Court by incandescent gas light.

gold five-burner Welsbach Multiflex lamps with which this installation is equipped. Lamps are all hung on ball joints, which insures them hanging perfectly vertical, and which are found by experience to absorb vibration.

It will be noted that sixteen lamps are required to light a single court, but

In the installation shown above only two courts out of four were to be lighted, but when the installation was made it was found that the entire four courts could be used, the centre two courts, of course, being better illuminated.

Modern Electric Show-Window Lighting.

DURING the last few years shop window lighting in the West-End of London has advanced to a fine art. The same may be said of the great continental cities, and we have also published photographs from time to time of good examples of store-lighting in the United States. Everywhere the advantage of good lighting as a means of attracting custom is receiving attention. Modern methods of illumination and improved means of transit now bring crowds into the streets by night, and a substantial portion of the trade is done in the evening by artifical light.

It is now recognized that tasteful and well-lighted windows form one of the best possible methods of advertising. Not only do they serve to interest people during the hours of custom, but even after the shop is closed they may still be lighted up and attract the notice of passers-by, in this way helping to increase interest in the establishment, and enabling the best possible value to be gained from a prominent position. Clearly it would be false economy, after securing a valuable and expensive site, to lose part of the advantages it presents by want of attention to the lighting,

Among the many striking displays in London an excellent example is that to be seen at Harrod's Stores. The frontage facing the Brompton Road occupies about 400 ft., and the ground floor windows are kept brilliantly illuminated up till 11 o'clock. Right up to this time people gather in knots on the pavement, and earlier in the evening the crowd is often very dense. The upper windows are shown illuminated in this photograph, but have been undressed. They are, however, always fully dressed until six o'clock, and provide an attractive spectacle for people riding on the tops of buses.

Fig. 1 shows a general view of the whole frontage, and Figs. 2, 3 and 4 show typical windows. The photographs bring out the excellence of the lighting, and do justice to the striking appearance of the display, but, of course, can give no idea of the exquisite mingling of colours to be seen. It will be observed that in these windows the highest form of dressing is expressed. That is to say, the contents of the windows are frequently changed, and an attempt is made, not to give a catalogue of the goods in the shop, but to show some specially attractive arrangement, a few choice samples, such as are bound to attract the attention of passers-by. A great deal of care is given to the dressing of these windows. People know that something new is always to be seen, and are on the look-out for it.

The method of lighting by concealed lamps at the top of the window is also most effective, the principle being similar to that utilized on the stage. The light is shed on the goods, but the actual lamps are kept out of sight, and their presence is not obtruded on the person looking in at the window. The illuminated window is a brilliant object compared with the comparative darkness of the street outside. Indeed, it is recognized that the drawing power of such windows, when properly lighted by artificial means, is considerably greater than in the daytime.

Each of these window-panels has an approximate front area of about 150 square feet; it is lighted by twelve 80 watt tungsten lamps, placed in special patent metal reflectors, made by the General Electric Co., Limited (who have also supplied similar reflectors to Selfridge's), arranged somewhat in accordance with the accompanying sketch (Fig. 5). The consumption of electricity is thus just about one-third of a unit per hour. The illumination of these windows demanded special skill, as in most cases it was not convenient to make use of a light opaque background. The effect is to flood the window with a uniform brilliant light, and measure-

FIG. 1.—Harrod's Stores. General view by night.

FIG. 2.—Window fitted with light goods at the same Store, illuminated by concealed Tungsten Lamps in special mirror-glass reflector.

Fig. 3.—Corner Windows, containing mainly light goods, illuminated by tungsten lamps in special mirror-glass reflector.

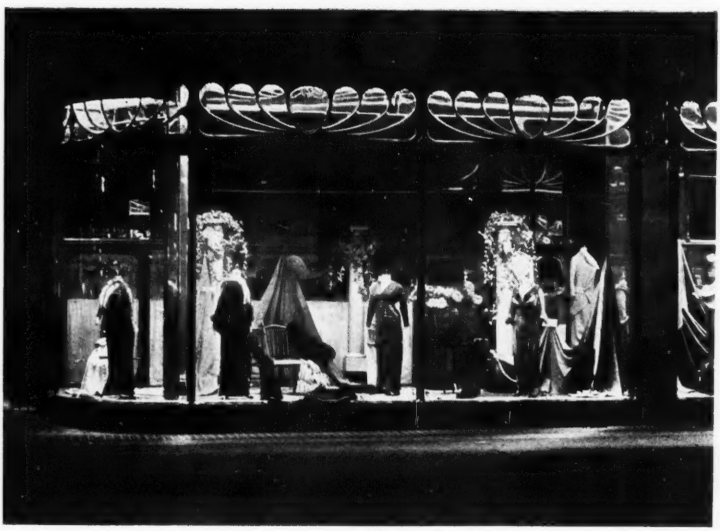


Fig. 4.—Another window also lighted by concealed lamps. The colour combinations in this window are especially fine.

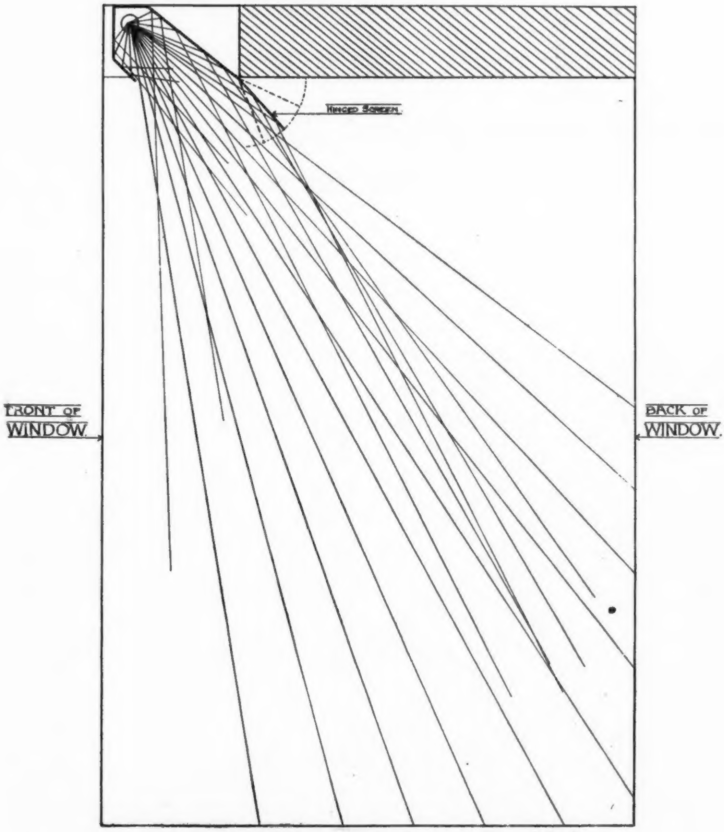


FIG. 5.—For letter-press under figure see the original.

ments showed that the surface brightness of the lighter objects approaches 15–20 foot-candles. The lighting of the upper floor windows is accomplished by somewhat similar methods, except that the lamps are here placed, like stage footlights, at the base of the window, so that they cannot be seen from the street.

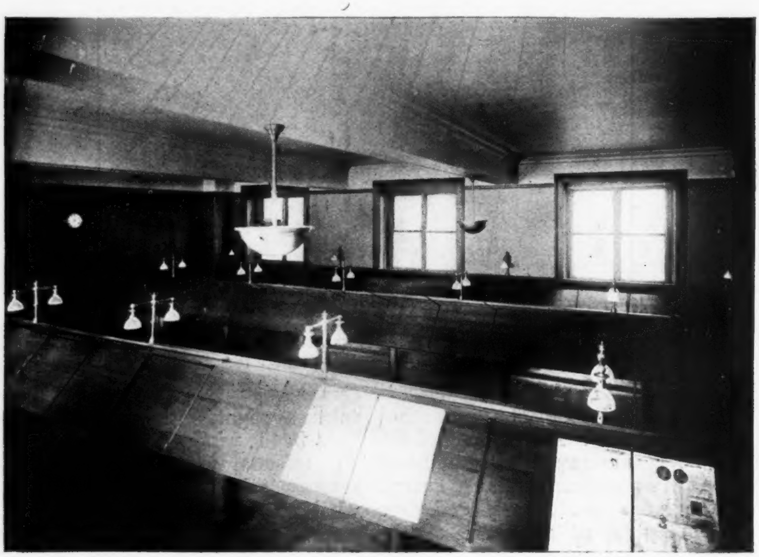
In conclusion, a word or two may be said about the special photographs accompanying this article. They were taken at night, entirely by the artificial light in the windows, and the exposure, &c., selected with a view to accurate representation of the appearance of the windows seen by night. In view of the well known difficulty of taking such photographs, when people and traffic are constantly passing in front of the camera, the results may be considered very satisfactory.

Combined General and Local Lighting in the St. Louis Public Library.

In a recent number of *The Electrical World* further particulars were given of the electric lighting of the St. Louis Public Library, and we are indebted to this journal for the accompanying photograph.

At the meetings of the Illuminating Engineering Society in Great Britain devoted to library lighting there was much discussion as to the comparative advantages of general and local lighting. The impression seemed to be that neither system was best in all circumstances. For example, in a students' reference library local illumination by well-shaded table lamps might be best, but for the news-room, where a cheerful illumination is required, the general method of lighting might be preferred. Perhaps the best method of all is to provide a small amount of subdued general lighting, and to add to this local illumination from well-designed portable lamps.

This method seems to have been utilized in the St. Louis Library. It will be seen that the general illumination is provided by semi-indirect opal bowls, and there are also table lamps on the respective benches. The opinion seems to be gaining ground that a moderate general illumination of this kind may be very conveniently produced by semi-indirect methods.



Bead Illuminated Signs.

By an Engineering Correspondent.

In the last five years the number of illuminated signs in London has multiplied enormously. It is true that we cannot rival the pyrotechnic displays of New York, and our advertising and spectacular display is not on the same scale as in that city. But at the same time the use of the illuminated signs for every-day practical purposes—for announcements and notices of all kinds—has made great strides, and considerable ingenuity has been shown in their design.

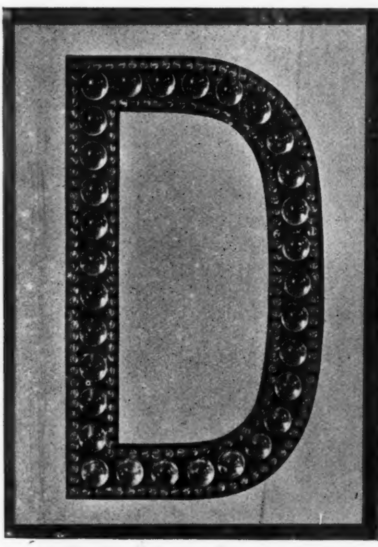


Fig. 1.—Showing method of constructing Letter Sign of spherical beads of various sizes.

Most of us can remember the time when the electric sign invariably took the form of words outlined in bare incandescent lamps. For a long time this was the only method. More recently such signs have been vastly improved, and considerable economies made by using low-voltage miniature metallic filament lamps. But among the most effective signs of to-day are those in which the lettering is lighted from behind. In this way more even distribution of light and more artistic results are secured; and it is naturally more economical in energy to do this than to compose the letters of actual lamp filaments.

One device which has proved useful is the employment of spherical glass beads, which can be set in any desired pattern and lighted from behind by

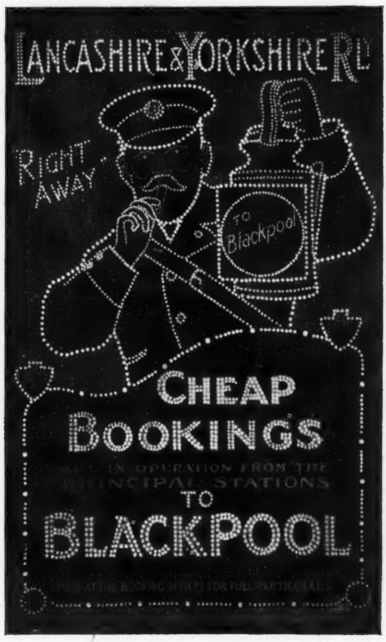


Fig. 2.—Typical Railway Sign, showing appearance by night when illuminated.

a few incandescent lamps in a metal box with a whitened interior. By the courtesy of Mr. R. F. Venner some examples of the Venner signs which utilize this method are here reproduced. Figs. 1 and 2 are photographs of two signs inspected at the Company's offices, and specially taken for this article. The first illustration shows a single letter made from beads

of various sizes, the second a typical sign for the Lancashire & Yorkshire Railway, such as are being used outside many of the underground railway stations in London.

The essential principle in these signs is the use of spherical beads riveted into the iron frame. It is believed that this spherical shape is essential in order to secure uniform brightness of the beads from whatever direction they are observed. It it also stated that the fact of the bead projecting from the surface enables the sign to be seen from oblique angles much more easily. Beads of various sizes can be used. This is necessary in order to follow a pattern or figure exactly, and it is also an advantage in differentiating between headlines and subsidiary matter in an announcement. Ordinary tungsten lamps are commonly employed, but the whole sign can be coloured by merely substituting tinted lamps. Another device is to streak the sides of the lamps with lacquer of various colours. The beads then appear to

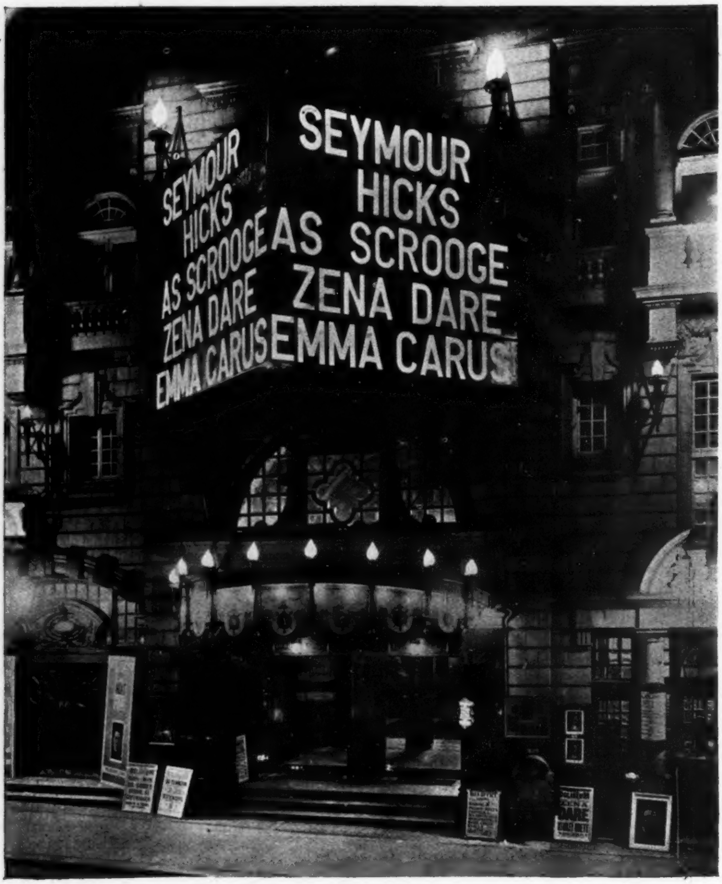


FIG. 3.—The well-known Bead Sign at the Coliseum, London, illuminated from behind by arc lamps.

be tinted in various colours, and the hues shift according to the direction from which the sign is viewed. At close quarters (as in Figs. 1 and 2) the separate beads can be seen. At a distance, however, the luminous dots run into one another, and the design appears continuous.

The remaining illustrations show several typical installations of these signs.

Fig. 3 is a night view of the well-known sign at the Coliseum. It is interesting because of its size, and because arc lamps are used to illuminate its interior. Fig. 4, the "paripan" sign, is of interest as being the very first sign of the kind to be put up in London. Fig. 5 shows another departure. It is a tramcar in Cardiff, bearing an illuminated bead advertisement instead of the customary enamelled iron placards. In the above case special lamps were provided, but it is conceivable that, with care, the lamps used to light the interior of a tram might be used for this purpose.

The possibilities of illuminated signs on moving vehicles seem to hardly be sufficiently recognized as yet. We may close this article by quoting the words of a recent correspondent in *The Westminster Gazette* on this subject:—

"In one direction I fancy there is going to be a great demand for cars which manufacture their own light. The possibilities for advertising which lie in this direction can scarcely be estimated. In city streets a vehicle can have placards brilliantly illuminated by filament lamps or can carry transparent advertisements lighted from behind. These have been experimented with already, but in most cases the light has been obtained from storage batteries. A dynamo run from the engine can provide ample electricity for brilliant illumination to the whole of an ordinary van, especially as powerful, heavy lights are not required for vehicles of this type. In a very short time I expect to see this mode of publicity

FIG. 4.—The first Venner sign installed in London.

FIG. 5.—Application of bead sign to a tramcar in Cardiff.

very popular with some of the big advertisers, and the first to adopt it will probably reap the reward of their enterprise."

The Luchaire Petroleum Standard of Light.

We have received from M. Guiselin, an account of the Luchaire petroleum secondary standard light used in the tests described by him in the October number of *The Illuminating Engineer* (p. 453). The name is that of the constructor of the lamp.

The burner utilizes a double current of air, and gives a very white flame with a good variety of illuminating oil. The burner is placed in a lantern having four panes, one being furnished with a rectangular aperture, the exposed area of which can be altered by means of a small metal piece moving between two vertical guides. In one of the other panes there is an observation aperture, covered by a piece of blue glass, through which one can inspect the pane and adjust its height to the right point.

Before using the lamp for photometric observations, it is compared with the standard Carcel lamp, which burns colza oil under certain prescribed conditions. A number of observations are taken and the movable piece in front of the window of the Luchaire lamp is set so that it gives an intensity of exactly one Carcel. The sliding piece is then fixed in position by a small drop of solder, and the lamp is ready for use. Provided the height of the flame is kept constant, and the same quantity of petroleum is used, one will always obtain from this lamp exactly the same light.

Value of Proper Direction of Light in Street Illumination.

Mr. S. B. Langlands speaks of the duty that he derives from the Kern burner, under Glasgow conditions, as 18 candles per cubic foot, and from the inverted burner as 21 candles per cubic foot. In public lighting we shall soon have to discontinue appraising the efficiencies of burners in this fashion, and advance to measurement that tells us something more about the efficiency of burners for the purposes to which they are applied. The mere statement of the candle-power of the source measured on the horizontal plane is interesting, but really of little value for lamps to be used for large space illumination—such as streets. The difference between the candle-power of the two burners as presented by Mr. Langlands is over 10 per cent, but with a bundle of the light rays of the one tending upwards, and a greater proportion of the light rays of the other tending in the opposite direction, the values of the burners have a distinct difference in street lighting which is not disclosed by the mere statement of the horizontal candle-power. This, of course, is all fully appreciated at Glasgow, as is testified by the gradual adoption of inverted burners.—*Journal of Gas Lighting.*

An Illuminated Aeroplane Fete.

An interesting development in aerial flight is the illumination of the aeroplanes themselves at night time. This plan has great spectacular possibilities.

A remarkable demonstration took place at Hendon on September 26th. The aeroplanes carried search lights, and were outlined by small electric lamps. The power for these was supplied from a series of portable accumulators carried on the machines.

Some Simple Illumination Devices in Use at the Crawford Technical Institute, Cork.

By the courtesy of Mr. C. E. Greenslade, Head of the Electrical Engineering Department at the Crawford Technical Institute, Cork, we have received some interesting illustrations of several ingenious devices contrived by him at this institution. The first of these shows the lighting adopted at the front entrance, photographs taken by daylight and artificial light being reproduced side by side. The source of light is placed on the top of the arch, and the fitting does not obtrude itself on the notice of visitors in the daytime. But at night the brightly illuminated arch attracts attention from the road, and guides people to the entrance at once. It will also be noticed that the

FIG. 1.—Porch illuminated at night.

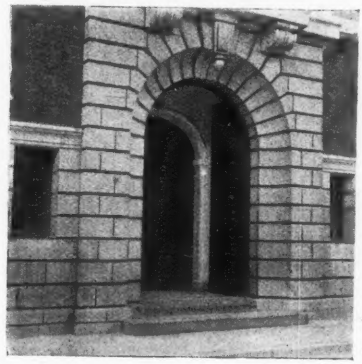


FIG. 2.—A daylight view of the same porch.

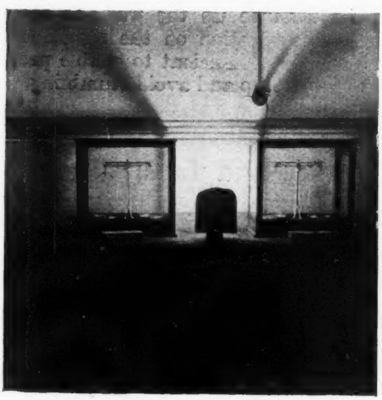


FIG. 3.—Showing simple device for illuminating balances in the chemical laboratory.

FIG. 4.—Showing simple device for illuminating balances in the chemical laboratory.

actual lamp is not visible to people inside the porch, but it enables any visitor coming to the door to be recognized at once.

The second illustration shows a very simple device employed in the chemical laboratories for illuminating the balances. A tantalum lamp is placed in a batten holder on a weighted base block, and fitted with a curved whitened zinc shade as shown. The lamp is then completely screened from the student's eyes, and the reflection from the wall on the bench is quite sufficient to enable him to write in the notebook.

The remaining illustration is interesting as showing how very simple methods will often do all that is necessary. The view on the right shows a point in a long passage at which a step occurs. Originally this was difficult to distinguish from a distance owing to the fact of the upper and lower levels of the floor having almost exactly the same tone. In the photograph on the left the step might actually not be recognized were it not for the piece of cardboard set up to mark the place. Taking a hint from *The Illuminating Engineer*, Mr. Greenslade added a white coating to the step, and carried this some distance up the wall, as shown in the illustration on the right. This proves quite sufficient to enable people to see the step and avoid stumbling.

FIG. 5.—The piece of cardboard marks the step which is difficult to see.

FIG. 6.—The same step made visible by a white line extending some distance up the wall.

Projecting Illuminated Signs and Lamps.

IN a recent number of *The Journal of Gas Lighting* particulars are given of an interesting case relating to some projecting signs outside the premises of the Clark Bread Company, Brighton. The Brighton Council demanded the removal of these signs, which consisted simply in gas lamps having the name "Clark" shown on them. It was contended that these came under the head of projecting signs, and that the Council had a right to demand their removal.

The position is a peculiar one. A lamp could apparently be allowed to remain if there was no name upon it, but if the fatal word "Clark" appeared upon it it became a "nuisance." It was contended for the appellants that the action contemplated by the Council involved an unduly rigid interpretation of an old Act of Parliament passed for an entirely different object.

The case has not yet been decided. It is one of some importance, as such signs are becoming exceedingly common.

The Lighting at the Machinery Exhibition (Olympia).

BY AN ENGINEERING CORRESPONDENT.

AT the various exhibitions recently held at Olympia it has been interesting to notice the methods of lighting employed. It must be confessed that as yet one does not see much sign of a deliberate attempt to fit the illumination to the exhibit. One would have supposed, for example, that at the Ideal Home Exhibition forms of lighting, and types of shades and reflectors specially suitable for private house lighting, would have been on show; and that the opportunity would have been taken at the Engineering Exhibition to use methods which are eminently adapted for factory and industrial lighting.

Moreover, the lighting of a stall should be modified according to the nature of the exhibit. Dark masses of metal, engines, &c., commonly require a high illumination in order to appear at their best, and the nature of the background is also important. It cannot be said that there was anything very noteworthy to be reported as regards the lighting of the engineering exhibits at Olympia, and it is evident that the value of more enterprising methods of illuminating stalls at exhibitions is not yet properly appreciated. In some cases naked unscreened lamps were placed close to the machinery they were intended to illuminate, in others fragile tinted glass shades such as would be quite unsuitable for industrial lighting were installed. Prismatic glass reflectors were occasionally used to concentrate the light on the exhibit with good effect—the stall of *The Practical Engineer* was an example. But there were also instances of their advantages being lost by improper use. For example, a stall not far away, was lighted by large, clear bulb lamps and ludicrously small reflectors, with the result that comparatively little light was directed on the engines below. Holophane reflector bowls were used with the Dreadnought milling file exhibit.

An attractive semi-indirect ceiling lighting installation was in use in The *Times* Engineering Supplement Office.

Cornice-lighting with tubular lamps was shown by the Linolite Co., at Kynoch's stall, in the Vacuum Oil exhibit and elsewhere. The Citroën gear display was lighted by flame arcs with parabolic reflectors, and *The Engineering Review* stall made use of Silica lamps and Cooper-Hewitt mercury lamps with fluorescent reflector.

Acetylene lighting was shown by Thorn & Hoddle, the Acetylene Corporation, Valite, Ltd., Carbic, and other firms; petrol air gas by the Praed and the International Air-Gas Co. The last named firm had an exhibit intended to show a mantle glowing in a confined space, all the requisite air for combustion being delivered in the mixture passing through the pipe. The high-pressure gas lights on the Keith & Blackman stall made a brilliant display, without there being anything very novel in their arrangement.

A word or two may be said on the lighting of the refreshment bars. Why, one knows not, but the illumination of such places is apt to suffer from neglect. The carbon filament lamps in obsolete reflectors yielded a conspicuously feeble light, and one cannot doubt but that a more enterprising system of illumination would have justified itself by attracting custom.

Lectures on Illuminating Engineering at Regent Street Polytechnic.

On Friday, October 25th, the first lecture of the course on Illuminating Engineering at the Polytechnic (Regent Street) was delivered by Mr. W. C. Clinton. Mr. Leon Gaster made a brief speech introducing the lecturer, and pointing out the value of such a course to those interested in lighting.

Mr. Clinton then explained that the lecture was of an introductory character, and he showed, by means of some ingenious models with travelling balls how light-waves travel. Subsequently, he dealt with the fundamental laws of reflection and refraction, and the nature of colour. A diagram of the eye was also thrown on the screen, and a brief explanation given of the nature of vision. Spectra of the arc, and of mercury vapour and neon tubes, were thrown on the screen, and the change in hue of a series of coloured materials, when exhibited successively in the light of the mercury tube (green) and the neon tube (red), were strikingly demonstrated to the audience.

An experiment with the ultra-violet light from an electric spark was next shown, and it was explained how quite a wide range of vibrations are similar in kind, the wireless electro-magnetic waves and the ultra-violet rays only differing in the frequency.

The next two lectures, on November 1st and 8th respectively, will deal with Electric Lighting.

A Proposed Gas Exhibition in 1913.

The important decision was also taken at the Manchester Conference to hold a gas exhibition in 1913.

Mr. F. W. Goodenough (Chairman of the Executive Committee of the British Gas Association) explained that it was proposed to make a distinct departure from the usual plan of exhibitions, a co-ordinated scheme being adopted throughout, in order to demonstrate the uses of gas in a novel and attractive manner.

Halls had been secured at the White City, at Shepherd's Bush, and it was proposed to illustrate gas lighting by equipping model shops of various kinds, model laundries, nurseries, schoolrooms, &c. It was also intended to give cinematograph displays showing the production of gas from the collieries to the finished article, and to work in co-operation with the Coal Smoke Abatement Society. A provisional committee to deal with the matter was accordingly appointed.

Illuminating Engineering Society

(Founded in London, 1909).

Official Notice of Next Meeting.

The First Meeting of the Next Session will be held at the House of the Royal Society of Arts (John Street, Adelphi, London, W.C.), on **Tuesday, November 19th,** at **8 p.m.**, when the Hon. Secretary will present a report of progress during the vacation, with special reference to his visits to the Continent and to the United States. It is also anticipated that novel and interesting apparatus of various kinds, including specimens from the collection of ancient lamps of Mr. J. W. Johnston, will subsequently be shown at the meeting.

School Lighting and Eye Strain.

THE lighting of evening schools was recently the subject of a special report by Dr. D. M. Taylor, S.M.O., to the Halifax Education Committee. He points out that illumination of rooms when evening classes are held is specially important in view of the fact that the scholars are often physically tired with their day's work, and any eye strain rapidly produces fatigue if brain-work is attempted.

The plan adopted up to now at Halifax for artificially lighting schools has apparently been that of a general illumination of all parts of the room, walls, roofs, &c., and the special requirements of the scholars have not received due attention. This is a fault to be found in most schools throughout the country.

To avoid eye strain and to facilitate work in evening schools, Dr. Taylor suggests that the following general principles, from the medical point of view, should be observed :—

(1) Light should not fall directly on the scholars' eyes.

(2) Light should be directed on their work; this is especially necessary in sewing and fine work.

(3) Blackboards should be well illuminated by a special fixed light screened from the scholars' eyes.

To effect the better distribution and economy of the present illumination, he offers the following suggestions :—

(1) Well-planned shades will ensure the light being thrown where needed.

(2) The gradual substitution of inverted incandescent lights, well shaded, would provide better lighting of the desks.

(3) The use of a more powerful electric bulb, *e.g.*, the Osram, at certain points.

(4) The protection of the gas mantles from dust. There is always a large amount of inflammable dust in schoolrooms, which, if allowed to settle on the mantle, may quickly lead to its destruction on lighting the burner.

Dr. Taylor adds that as cases arise in future great improvement at little cost could be effected by the joint visit and consultation of the borough lighting engineer and the school medical officer. —*The Medical Officer*.

Review of Books.

Modern Illumination in Theory and Practice. By H. C. Horstmann and V. H. Tousley. (The American Book Supply Co., 149, Strand, London, W.C.; 1912. 8*s*. 6*d*. net.)

In the Preface it is stated that this book is "intended for the practical workman rather than the student," which, we think, is borne out by its contents. It contains 273 pages, and the treatment is very condensed. In many cases the authors confine themselves to definite statements when some fuller explanation or qualification might be desirable. A short summary is given of electrical illuminants, but the bulk of the work is devoted to illumination calculations, information on the planning of installations, &c. The collection of tabular matter on constants of illumination, standard symbols, &c., is exceptionally complete. The book should be useful in the hands of those who have already some knowledge of illuminating engineering and understand that hard-and-fast rules cannot be followed too rigorously. It may be remarked that the title seems somewhat too general, and is hardly suitable for a work which deals only with electrical illuminants.

Some Publications Received.

Developing of an Industry.—This is the title of an admirably got-up presentation book, written by Mr. Phillip E. Dodd, sketching the development of the National Electric Lamp Association (now the National Quality Lamp Division of the General Electric Company). The story of the gradual fusion of the various concerns interested in the manufacture of incandescent lamps during the last ten years is a remarkable one. Equally interesting is the account of the magnificent research laboratory at Cleveland. The smooth working of this huge concern is due in no small measure to the untiring efforts of its leaders. The system, foresight, and determination of the genial Mr. F. S. Terry and the sound business instinct of Mr. B. G. Tremaine, form a happy combination which has contributed greatly to the success of this undertaking.

One interesting branch of the work has been the method of deciding rates such as will suit both the lamp-maker and the central station—a portion of the work in which Mr. S. E. Doane, the chief engineer, has been largely interested. This volume is abundantly illustrated. Not the least striking of the pictures are those representing the camp life of the officers of the Association when, during a part of the year, the staff meet together in the open air on "Association Island."

Technical Instruction in Cork. By J. H. Grindley, D.Sc., M.I.Mech.E. (Issued by the Department of Agricultural and Technical Instruction for Ireland.)

In this publication the progress of technical instruction in Cork since 1884 is reviewed. Cork now possesses four municipal schools, a school of Science and Technology (the Crawford Institute), a school of Art, and a school of Music. Special attention is devoted to the Crawford Technical Institute, which appears to be very well equipped. We notice that in the account of the equipment of the Institute special mention is made of the lighting. It is remarked :—

"The electric lighting of the building has been carefully studied, some special features having been introduced, and the room lighting having been subject to precise determination as to the degree and kind of illumination most suited to the purpose for which each room was to be used. For example, the lighting of the Drawing Offices and Library is accomplished by fittings of conical form, each of which reflect the light from a nest of four incandescent lamps on to the ceiling, and give at the level of the desk or table a fairly strong light with only slight shadows."

Would that the illumination received even so much attention in the prospectus of all institutions of the kind!

The *Transactions of the American Illuminating Engineering Society* for June contains two specially interesting items. The first of these is a symposium on direct, semi-indirect, and indirect lighting. The second is the primer on illumination, entitled 'Light : its Use and Misuse' (of which we have also received a special copy).

We hope to deal more fully with this pamphlet shortly. Meantime, we need only say that it is abundantly illustrated, and is written with a view to presenting in simple form those fundamental rules which must be followed in order to secure good illumination and the various defects which are emphatically to be avoided.

The Gas Institute News for October contains an interesting contribution by Mr. C. O. Bond on 'The Photometry of Gas Lamps.' Among other publications received, we have to acknowledge the *Proceedings of the American Philosophical Society, American Academy of Arts and Sciences*, and *The American Chemical Journal.* The last instalment of the *Transactions of the Institution of Civil Engineers* (*London*) also contains a very varied and instructive series of papers on general engineering subjects.

Heat Tests of Alternate-Current Transformers, by J. T. Morris, J. W. Elliott, and D. Lewes, reprinted from *The Electrician*, Jan. 26 and Feb. 2, 1912.

Experiments on a Mercury Arc Converter, by J. W. Elliott and C. S. Parsons, reprinted from *The Electrician*, July 14, 1911.

Negative After-Images and Successive Contract with Pure Spectral Colours, by A. W. Porter, B.Sc., F.R.S., and F. W. Edridge-Green, M.D., F.R.C.S., reprinted from the *Proceedings* of the Royal Society (London) B, vol. lxxxv., 1912.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

An important contribution to this section is the series of papers read by the Convention of the American Illuminating Engineering Society; these are noticed elsewhere in this number (see pp. 491–8).

There are several papers dealing with **industrial lighting.** R. G. Beck (*Electrical World*, Oct. 5th) deals with the **lighting of steel mills.** He discusses the respective advantages of various reflectors, and gives a table for the illumination required in various departments. For general purposes 0·5 to 1 foot-candle is regarded as sufficient. For inspectors' tables at least 3½ foot-candles are necessary, and for fine work and in the drawing office at least 5 foot-candles.

C. E. Clewell (*Proc. Amer. Inst. Elec. Eng.*, July) deals with **industrial lighting** in general. He draws special attention to the limitations imposed by the height of the ceiling, and gives a diagram showing the comparative overall lengths of the chief electrical illuminants. In conclusion, he mentions some experiences showing how accumulations of dust affect the illumination. In a large factory it is well worth while to pay the wages of a staff to superintend the lighting appliances and keep them clean.

Dr. L. Bell (*Electrical World*, Oct. 5th) contributes an attractive article on the **exterior lighting** of the **Boston Electrical Show;** and J. R. Cravath, in the same number, discusses the street lighting rates.

P. S. Millar (*Electrical World*, Oct. 12th), writing on efficiency in illumination, traces the gradual stages in development of Illuminating Engineering: the recognition of the need for shades and reflectors and the avoidance of glare, the design of measuring instruments, and the insistence of efficiency. Now the artistic side of the subject is being studied with greater care, it is seen that there are many cases in which efficiency is of small consequence in comparison with ornamental effect.

Turning next to fixtures, we may note the article by H. K. Ritter describing a **new form of lighting unit** consisting in the combination of a metal reflector with a lower conical glass vessel. In the surface of the glass grooves are made, the intermediate space being lightly obscured, and it is claimed that by the combined effect of reflector and diffuser glare is avoided, and that the loss of light is very small. Recent numbers of *Licht und Lampe* contain illustrated accounts of various forms of shades and reflectors. Especially interesting are the newer types of silk shades and hangings.

In connexion with Photometry we may note the exhaustive paper by H. E. Ives (*Phil. Mag.*, July), which deals with **colour-photometry** and the **flicker photometer.** His conclusions are, on the whole, favourable to this instrument, the most striking point being the apparent existence of a reversed Purkinje effect at low illuminations for the flicker photometer.

R. Pauli (*Zeitschr. f. Instr.*, Sept.) describes a new form of **acuteness of vision photometer.** The results obtained appear to depend to some extent on the adaptation of the eye.

ELECTRIC LIGHTING.

The most interesting article in this section is, perhaps, that of L. Bloch (*Elek. u. Masch.*, Oct. 13th), which discusses some forms of shades and reflectors for metal lamps. He illustrates some forms of cylindrical translucent shades.

D. H. Ogley (*Elec. Rev.*, Sept. 20th) describes some researches on tungsten lamps. Whereas the resistance of carbon filaments in general rises uniformly during life, that of tungsten filaments behaves very irregularly—usually rises and then falls. This is only to be explained on the basis of the crystalline state of the metal filament.

There are several general articles in the French papers summarizing the qualities of tungsten lamps. A. Strauss

(*Licht und Lampe*, Oct. 10th) compares the efficiency of arc lamps and metal filament lamps, laying stress on the advantages of high candle-power tungsten filaments.

An article in the *Zeitschr. für Beleuchtungswesen* describes a new method of automatic electrical staircase lighting.

The Electrical World (Sept. 21st) deals with the use of **electric lamps for signalling in hospitals.** A method is described enabling patients to call the attention of a nurse by a pull-connexion lighting up a lamp in the passage; this is also recorded in the central offices, so that it can be observed how soon the signal is answered by the nurse.

GAS, OIL, AND ACETYLENE LIGHTING.

Much attention has been given to the first Annual Meeting of the British Commercial Gas Association at Manchester, an account of which is given elsewhere in this number (pp. 499–501). An article by T. J. LITLE on 'Playing Tennis by Incandescent Gas Light' is also dealt with in this number.

A matter which is now receiving considerable attention is the development of more artistic **fixtures for gas lighting.** This is the subject of an article by W. W. Barnes (*Am. Gas Light Journal*, Sept. 30th). *The Journal of Gas Lighting* (Oct. 8th) illustrates some specially designed fixtures for the Birmingham Corporation.

In *The Gas World* (Oct. 6th) some special new Sugg fittings are shown. These include a novel reflector for shop-lighting and a semi-indirect lighting unit. This is of special interest, as showing how the methods applied to electrical lighting are also coming to be used with gas.

In the account of the Exhibition at Amsterdam a description is given of a new form of intense gas lamp using the pressure of mercury vapour. This is said to give good results without affecting the colour of the light.

Recent numbers of the *Revue des Éclairages* contain several articles on acetylene, notably an account of the development of the industry in Turkey.

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Bell, Dr. L. The Exterior Lighting of the Boston Show (*Elec. World*, Oct. 5).
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Cravath, J. R. Street Lighting Rates (*Elec. World*, Oct. 5).
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Elliot, E. L. Juggling with Illumination (*Am. Gas Light Journal*, Oct. 14).
Hirschberg, L. K. New Discoveries in Lights and Flames (*Am. Gas Light Jour.*, Aug. 19).
Ives, H. E. Studies of the Photometry of Light of Different Colours (*Phil. Mag.*, July).
Lapersonne, F. de. L'Eclairage Artificiel et le Protection des Yeux (*Rev. des Eclairages*, Oct. 15).
Millar, P. S. Efficiency in Illumination (*Elec. World*, Oct. 12).
Pauli, R. A New Acuteness of Vision Photometer (*Zeitschr. f. Instrum.*, Sept.).
Ritter, H. K. A New System of Illumination to avoid Glare by Diffusion ((*Elec. Rev. and West. Electrician*, Sept. 28).
Schuller, A. Die Schwarzungsgesetz fester lichtempfindlicher Schichten (*Zeitschr. f. wiss Photogr., &c.*, Sept.).
An Indirect Effect in Architectural Illumination (*Elec. World*, Sept. 28).
Experimental Street Lighting in Manchester, *J.G.L.*, Oct. 15).
Notes on Old Methods of Lighting (*Am. Gaslight Jour.*, Oct. 7).
A Merchants' Shop Window Lighting Contest, *Elec. World*, Sept. 28).
Emergency Lighting in Theatres (*Elec. Rev. and Western Electrician*, Sept. 21).
The Illuminating Engineering Society Convention (*Elec. Rev. and Western Electrician*, Sept. 28).
Lampen mit Stoffbehang (*Licht u. Lampe*, Sept. 26).

ELECTRIC LIGHTING.

Bloch, Dr. L. Reflektoren und Armaturen für die Beleuchtung von Innenräumen mit Metalldrahtlampen (*Elek. u. Masch*, Oct. 13).
Färber, F. Neue elektrische Grubensicherheitslampe (*E.T.Z.*, Oct. 3; *Licht und Lampe*, Oct. 10).
Henry. La Lampe à arc et la lampe à tungstène (*Electricien*, Oct. 5).

Marchand, H. A propos des lampes à filament métallique (*Electricien*, Sept. 21).
Ogley, D. H. The Characteristics of metallic filaments (*Elec. Rev.*, Sept. 20).
Sauquet, A. Étude comparée du rayonnement dans la lampe Osram et dans la lampe à filament de charbon (*Rev. Electrique*, Oct. 11).
Strauss, A. Bogenlampen oder Metallfadenlampen (*Licht u. Lampe*, Oct. 10).
Uber Selbsttätige elektrische Treppenbeleuchtung (*Z. f. B.*, Oct. 20).
The New Street Lighting in Chicago (*Elec. World*, Oct. 12).
Lamp Signals in Hospitals (*Elec. World*, Sept. 21).
High-Pressure Gas *v.* Flame Arcs for Street Lighting (*Elec. Rev.*, Oct. 18).

GAS, OIL, AND ACETYLENE LIGHTING.

Barnes, W. W. The Rejuvenation of Gas Lighting Fixtures (*Am. Gaslight Jour.*, Sept. 30).
Conroy, J. P. Performances of Gas Lamps (*Am. Gaslight Jour.*, Sept. 30).
Litle, T. J. Playing Tennis by Night by Gas Arcs (*Am. Gaslight Jour.*, Sept. 16).
Stavorinus, D. The International Gas Exhibition at Amsterdam (*G. W.*, Sept. 21, 28).
The First Annual Meeting of the British Commercial Gas Association (*G. W.*, Oct. 12; *J. G. L.*, Oct. 8, 15).
Handsome Gas Lighting Fittings (*J. G. L.*, Oct. 8).
The Gas Lighting Development of a Typical British City (*Am. Gaslight Jour.*, Sept. 30).
Wm. Sugg & Co.'s New Lighting Fittings (*G. W.*, Oct. 26).
Die Fabrikation von Glühlichtstrumpfen aus Kunstfasern (*Licht u. Lampe*, Oct. 10).
Le Nouveau Bec à Incandescence (*Rev. des Eclairages*, Sept. 30).
L'Acétylène en Turquie (*Rev. des Eclairages*, Sept. 30).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. u. Masch.—Elektrotechnik und Maschinenbau.
G. W.—*Gas World.*
J. f. G.—*Journal für Gasbeleuchtung swesen.*
J. G. L.—*Journal of Gaslighting.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

The Artificial Lighting of Low-Roofed Factories.

The Union Electric Co., Ltd. (Park Street, Southwark), have issued an attractive pamphlet under the above title emphasizing the advantages of the "Eye-comfort" system of lighting with indirect and semi-indirect arc lamps. Some photographs of bakeries, offices, and workshops of various kinds, taken entirely by artificial light, are reproduced.

The chief points made in lighting factories are stated to be: (a) the light to be ample in quantity, equable, and evenly diffused; (b) there should be no glare (and consequent eyestrain and liability to accident); (c) the light should approximate daylight, not only in its colour, but also in its ability to reveal the colours correctly.

We have also received the Catalogue of the Union Electric Company, containing particulars of arc lamps, dynamos, motors, and instruments (list No. 92).

The Linolite Company (25, Victoria Street) draw attention to their "Woodhouse" steel casing for electric leads.

The British Westinghouse Electric and Manufacturing Co., Ltd.: Particulars of their latest forms of instruments (Lists 342/4, 342/7, and 345/15).

Messrs. Verity's Lamp (31, King Street, Covent Garden, W.C.).

Catalogues of Aston Electric Drills and Grinders, and also Electric Radiators.

Gilbert Arc Lamp Co. (St. Albans, Herts).

Particulars of the Culinan and White Star Arc Lamps: Three of these lamps in series of 220 and 250 volts give a total m.h.c.p. of 1,800, some only 1·1 units per hour.

'Lighting News.'

Lighting News is a novel little publication issued by the British Thomson-Houston Co. Its dimensions are only $4\frac{3}{4}$ in. by $3\frac{1}{2}$ in., and it contains, for the size, quite an astonishing variety of matter. The back, front, and inside covers are occupied by miniature advertisements of Mazda lamps and Holophane reflectors. The literary matter includes articles on such subjects as: 'Electric Light Terms Explained,' 'How to Read your Electric Light Meter,' 'Indirect Lighting,' 'Shop-lighting,' &c., and it is concluded by a humorous illustrated story entitled 'Bobson's Conversion.'

The general get-up resembles that of a weekly paper in miniature. The Company are prepared to supply *Lighting News* in reasonable quantities overprinted with contractors' names and addresses.

The Robinlyte Mantle.

At a dinner given by the **Robinlyte Amalgamated Companies, Ltd.,** at the Hotel Cecil on October 10th an opportunity was afforded of seeing the new "Robinlyte" mantle. This consists of a bundle of flexible crimped threads, which, it is claimed, may be poked, knocked, or folded without the slightest injury. The mantle is also remarkable for exposing an exceptionally large area of active surface to the flame, to which it adapts its shape very readily, thus using the heat to the very best advantage. The mantle is also claimed to maintain its shape, and to be proof against the defects of splitting and cracking during use.

It is also stated that the consumption of gas necessary to produce a certain light from these mantles has been reduced to an exceptionally low figure.

B.T.H. Mazdaliers.

An Innovation in Electric Light Fittings.

It is somewhat curious, in view of the amazing advances that have taken place in nearly every other form of electrical apparatus, that so few developments and improvements should have been made in the design and construction of electric light fittings.

Hitherto almost the only available form of inexpensive electrolier has been the cluster or spider fitting, suspended on flexible cord, and equipped with "fancy" glass shades. Such fittings are not only unattractive in appearance, but, owing to the lack of design in the spacing of the arms and length of drop, give very poor lighting results.

The British Thomson-Houston Company have introduced a new and improved kind of fitting called the "B.T.H. Mazdalier," the advantages of which may be summarized as follows :—

Mazdalier Advantages.

(1) Mazdaliers are packed in pasteboard cartons, and every part is wrapped in moisture-proof paper. These packages can be easily carried and stored, and large stocks can be accommodated in a very small space. Every fitting is preserved in its pristine factory condition without the slightest tarnish.

(2) Mazdaliers come completely wired and fitted with holders and galleries. They can be easily and rapidly fixed, and made ready for service in a few minutes.

(3) The list-prices cover holders and galleries, all completely wired—everything, in fact, but reflectors and lamps.

(4) For a trifling capital outlay and in a small showroom a contractor can hold a large and varied stock of these compact fittings.

(5) By stocking a few of these fittings the contractor is in a position to execute experimental or temporary installations with a minimum of damage to the fittings and trouble to himself.

(6) In shops, offices, houses, &c., whenever it is necessary to remove fittings, Mazdaliers can readily be taken down, packed in cartons and stored, and kept in good condition until required.

(7) The prices of these fittings are so low that they can be used advantageously in place of cord clusters.

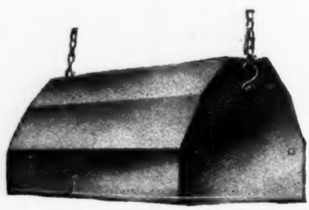
Mazdaliers are supplied in square- and round-tube types for single lamps, or with two, three, four, or five arms, and in two finishes : Cloister (a rich oxydized copper) and Brushed Brass (a dull brass finish).

The development of these fittings represents another stage in the B.T.H. Co.'s "Good Lighting" campaign. First, the Company placed the Mazda lamp on the market ; next, they turned their attention to the provision of scientific and artistic reflectors ; finally, they have produced the Mazdalier fitting described above. By the supply of these lighting appliances, and with the assistance (in an advisory capacity) of the Company's Illuminating Engineers' Department, the contractor is enabled to meet every requirement of scientific and satisfactory illumination.

The Uniflux Reflector.

In our last number we drew attention to the new **Benjamin Electric** Catalogue. One interesting unit described therein is

the new "Uniflux" reflector, which is intended for illuminating extensive black areas, blackboards, diagrams, facias, &c. Two models of this reflector are shown in



the illustration. It is anticipated that the Wratten daylight screen may be applied with this reflector, so as to give true colour values in picture lighting.

The Hygiene of Lighting and Heating.

This is a readable publication of the British Commercial Gas Association, setting forth the claims of gas for heating and lighting.

Frequent reference is made to the well-known researches of Dr. F. S. Toogood, Dr. S. Rideal, and Prof. Vivian Lewes in order to substantiate the contention that in ordinary properly ventilated rooms the use of modern gas-lighting is not prejudicial to health; on the contrary, in some circumstances, it may be applied to improve the existing ventilation.

We have received from **Messrs. W. T. Henley's Telegraph Works Co., Ltd.** (Blomfield Street, London Wall, London, E.C.), an interesting and fully illustrated reprint, describing a visit to their cable factories at Woolwich and Gravesend.

A New Adjustable Reading Lamp.

The General Electric Company, Ltd. (67, Queen Victoria Street, London, E.C.), send us particulars of a new adjustable reading lamp, which is shown in the accompanying illustration. Its movements are "universal," enabling the light

to be directed at any angle. There is also a special revolving shade, by which the light can be screened or projected. The lamp is claimed to be specially suitable for the work of dentists, oculists, engravers, and others.

Osram Filaments for Mining Lamps.

It is interesting to mention that in the miners' safety lamps winning the first prize of £600 and the second, third, and fourth prizes of £50, 1·5 c.-p. 2-volt Osram filaments were used. These lamps consume little current, and the expense is only a halfpenny per shift of approximately twelve hours.

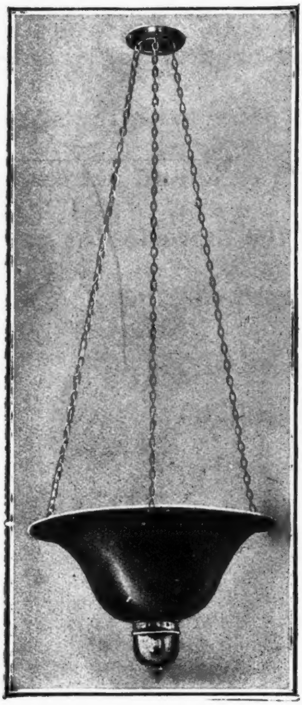
Shop-window Lighting.

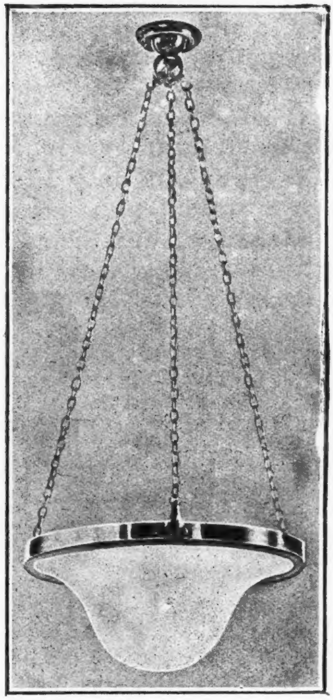
The **British Thomson-Houston Co., Ltd.** (77, Upper Thames Street, London, E.C.), have designed a method of window-lighting with a view to securing (1) uniform illumination, (2) absence of glare, and (3) absence of shadow in one part of the window. Suitable metre or silvered glass reflectors are ranged behind the facia, and cast their light down in the manner shown by the illustration. Reflectors of the extensive, intensive, or focussing description are used, according to the dimensions of the window, the intention in all cases being to flood the goods with light, and to prevent the filaments dazzling the eyes.

Forms of Indirect and Semi-Indirect Fittings.

The next two illustrations show forms of indirect and semi-indirect fittings brought out by the **British Thomson-Houston Co.** (77, Upper Thames Street, finished outside with grey enamel and inside with matt aluminium.

The new line of semi-indirect fittings are also supplied in two types, one for clusters of lamps up to six in number, the other for single lamps. The semi-indirect types have the advantage that





E.C.), from whom fuller particulars can be obtained. The industrial indirect types are made in two styles, giving respectively diffused and concentrating light effects, and in three sizes for the 60 watt, 100 watt, and 200 watt Mazda lamp. The bowls are made of metal, and while diffusing the lamp from the ceiling they allow a mildly luminous opal bowl to be seen, and give a more familiar aspect to the installation.

These fittings are described in the B.T.H. folders Nos. 2295 and 2296 respectively.

From **The Metallic Seamless Tube Co., Ltd.** (Wiggin Street, Birmingham), we have a series of pamphlets describing their "Meta" Flat Switches. These are made in all the standard forms, and there are also a Colonial pattern fitted with a steatite movement suitable for humid atmospheres, and a pattern having a grooved base for surface wiring.

Messrs. Saville & Walton (8, Bream's Buildings, London, E.C.) send a pamphlet giving a selection of their Lighting Specialities, especially in connexion with country house lighting.

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ELECTRICITY · ACETYLENE · OIL · GAS

The
ILLUMINATING
ENGINEER

Edited by
LEON GASTER

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EDITORIAL.

The German Illuminating Engineering Society.

To many in this country the announcement of the formation of the German Illuminating Engineering Society on pp. 538-540 will come as a pleasant surprise. The public announcement of this important step has only just been made, but the preliminary work has been steadily going on for some time, and the events of the last few years have shown quite clearly the need for such a Society in Germany. The United States and England have both Illuminating Engineering Societies to represent them in matters of illumination, and other countries are now recognizing their value, especially as illumination promises to be the subject of much international discussion during the next few years.

The first step taken by the Reichsanstalt after it had been decided to form the Society, was to write for particulars of the Illuminating Engineering Society in Great Britain. Accordingly the writer, during his recent visit to Berlin, took the opportunity to see Dr. Brodhun and Dr. E. Liebenthal at the Reichsanstalt and give them full information on this subject.

There is no doubt that the experiences of the British and American Societies will be very useful to our friends in Germany. The extracts published from the proposed constitution show that the German Society is to be closely modelled on our own. The Council is to consist of twenty-four members, six drawn from the Verband deutscher Elektrotechniker, six from the Verein für Gas und Wasserfachmännern, and the remaining twelve from other bodies unconnected with gas or electricity. For the time being, however, the affairs of the Society are to be conducted by a provisional committee, on which Prof.

Warburg, Director of the Reichsanstalt, is Chairman, and Dr. E. Liebenthal Secretary; while Dr. Brodhun and Dr. Hagen (of the Reichsanstalt), Dr. Bunte and Herr G. Dettmar (representing respectively the German institutions of Gas and Electrical Engineers), are also on the Committee.

Early in the year an appeal to the Reichsanstalt to undertake the formation of the Society was made by the Institute of Electrical Engineers, and this afterwards received cordial support from the Institution of Gas Engineers. A year or two back co-operation of this kind between representatives of gas and electricity would have been much more difficult to attain, but, as stated above, the events of the past few years have shown the vital need for an impartial body to deal with illumination, nomenclature, standards of light, &c., and the institutions of gas and electrical engineers have accordingly joined hands in this matter.

The decision to approach the Reichsanstalt was undoubtedly a wise one. No other body in Germany could have stood in quite the same impartial position towards the various illuminants concerned, and its influential and authoritative support will naturally be of considerable benefit to the new Society. Germany has done much for science, and many of the earliest pioneering investigations on photometry and illumination were carried out in that country. It is very gratifying to find that our own experience is confirmed by the German experts in illumination.

We observe that the first meeting of the German Society is to be held next February, and that it is hoped that Prof. O. Lummer will give the inaugural address. We need not say that we in this country cordially welcome the formation of the Illuminating Engineering Society in Germany. We feel confident that the three illuminating engineering societies now in existence—in England, Germany, and the United States—will co-operate together for much useful and international work in the future.

Light and Illumination: Their Use and Misuse.

A Primer on Illumination.

It will be recalled that in our last number we referred to the Primer on Illumination issued by the American Illuminating Engineering Society. In this issue we are publishing a somewhat similar series of notes entitled 'Light and Illumination: their Use and Misuse,' which will subsequently be reprinted in pamphlet form. The text has been remodelled somewhat to suit the conditions of this country, but it will be observed that the views put forward are practically identical with those published in the United States. Great credit is due to the American Society for having taken this step, and we are glad to co-operate with them in spreading the knowledge of good illumination.

It need not be said that there are many matters on which lighting engineers have not yet formed a definite opinion, and many suggestions which have yet to stand the test of time and experience. Illuminating Engineering is a new movement. It has had to formulate tentative rules in a comparatively short time, and many of them may have to be modified within the next few years.

Therefore in this publication every effort has been made to avoid dogmatic utterances on any points which are doubtful.

On the other hand, there are certain fundamental rules of good lighting which have stood the test of time and have received such general approval on the part of those interested in this subject that there need be no hesitation in putting them forward.

During the last few years enormous progress in methods of illumination has been made, and it is therefore to the advantage of the consumer to be able to know how to get the best value from his lamps. He needs to

be shown that there are certain simple rules which apply equally well to all methods of lighting, and ought almost invariably to be observed.

A special effort has been made in this article to put the case for good illumination in simple and concise language, and liberal use has been made of illustrations. At the same time it is only right to say that the matter has been got together somewhat hastily, owing to the urgent requests of some members of the Society for an immediate issue of the pamphlet. No doubt there will subsequently be opportunities of making such improvements as may appear desirable.

For the moment the illustrations used are examples of electric lighting. But the text applies equally well to all illuminants, and we hope before long to reissue this publication, in which the text will be substantially the same, but the illustrations will deal with gas lighting.

We should like to mention that it has naturally been necessary to make the contents of this primer very general. There are many problems which are peculiar to one branch of lighting, such as are involved, for example, in the lighting of shops, schools, streets, factories, &c., which cannot be included in its scope.

It is proposed in the near future to follow up this first series of general recommendations by a succession of pamphlets dealing specifically with special branches of lighting. But before this is done it would be well to collect further data and obtain fuller experience on some points so that the information can be presented to the public in as definite and attractive a form as possible.

Expert Opinion on Manchester Street Lighting.

On pp. 534-537 we reproduce the main points in the reports of Mr. Haydn T. Harrison and Mr. J. Abady, the two experts invited by the Manchester Council to report on the gas and electrical lighting in that city. This enterprising departure has caused much interest and speculation, and since the issue of the reports there has naturally been a considerable amount of discussion in the technical press.

It is not to be expected that the many-sided questions involved in street lighting can be easily settled. Until we have something in the nature of a standard specification on street lighting it is hardly to be expected that strictly comparable data will be obtained by two independent experts, even though they may be anxious to co-operate together. In the present instance we consider that the results obtained are distinctly promising in view of the novelty of the situation. Who would have anticipated a few years ago that a City Council would invite two experts to report upon the lighting in this way?

It must not be supposed simply because an inquiry of this kind fails to carry complete conviction to all parties concerned, or does not lead to an immediate decision in favour of one system of lighting or other, that it is useless. On the contrary, the very fact that so much discussion is aroused proves that the difficulties are, at any rate, being faced. We believe that it is only by attacking these questions through the co-operation of representatives of the competing illuminants, working together on predetermined lines and using mutually acceptable methods, that the requirements of street lighting would gradually become standardized.

There is one point which, we imagine, will have struck many people who read these reports, namely, the fact that the positions of the lamps and the conditions under which they were working were not the best. It is admitted, for example, that the gas-lamps were not operating as satisfactorily as the same class of lamps has done elsewhere, and this naturally invalidates the comparison to some extent. We think that

it would have been possible, before this series of investigations commenced, to make sure that the working of the lamps was normal and efficient; or, if the defects only revealed themselves while the tests were taking place, to have them remedied and further experiments made before the reports were issued. If this had been done it would have added considerably to the value of these experiments.

We hope on a future occasion to go more fully into the merits of these tests and the results obtained.

The International Cinematograph Exhibition and Conference.

We hope that some of our readers and members of the Illuminating Engineering Society will take advantage of the invitation (page 530) to participate in the International Cinematograph Exhibition and Conference to be held at Olympia next March. At first sight it might perhaps be thought that lighting engineers are not very practically concerned with cinematograph displays. But on closer consideration it will be seen that there is really quite a field for illuminating engineering in this work.

Let us take first the illuminating apparatus used for projecting the film on the screen. The cost of electrical energy in running one of these powerful arc lamps continuously during the day is naturally considerable. Yet of the vast amount of light created only a comparatively small amount actually reaches the screen. The loss involved in transmission through the film and optical system is often very large. Could we but devise a method of increasing, if even only slightly, the percentage of light *usefully* employed the saving would be great.

The design of the lens system, the nature of the source of light used, and, in particular, the way in which this light is distributed are all of importance. There is likewise an opportunity for investigations in connexion with the screens used in cinematograph work.

Next there is the question of the lighting of the rooms in which the cinematograph displays are held. Very subdued lighting is naturally desirable in order that the brightness of the screen may appear correspondingly great. We have been in many rooms in which the lack of effective methods of screening made the glare when the light was turned on distinctly painful.

It need not be said that there is also room for ingenuity in arranging the exterior lighting of picture palaces. There is no doubt that the use of luminous signs and striking methods of lighting at the entrances constitute a very important means of attracting patronage to this class of entertainment.

Finally, we should like to see some additional information as to the precautions to be taken regarding the eyesight of children who habitually visit cinematograph entertainments. We have seen it stated that it is bad for the eyes to be too close to the screen, and that this applies with special force to the vision of children. The difference in the comfort with which the screens in various theatres can be viewed is quite pronounced. In some cases the standard is uniformly high, and the eye is scarcely conscious of any degree of objectionable flicker; in others, one's eyes become tired by the flicker in quite a short period. It is to the interest of the cinematograph industry to determine exactly which conditions are prejudicial to eyesight and to aim at eliminating these difficulties so far as possible.

We have now mentioned a few matters which constitute common ground for the lighting engineer and cinematograph expert. We do not doubt that there are many others well worth discussion, and we hope that some of our members will find the opportunity to bring these forward.

LEON GASTER.

Review of Contents of this Issue.

THE first article in this issue, by DR. LOUIS BELL (p. 531), describes the decorative lighting at the **Boston Electric Show,** which appears to have been on a very extensive scale.

Following this will be found an abstract of the two reports presented by MR. HAYDN T. HARRISON and MR. J. ABADY on the **Street Lighting in Manchester** by Gas and Electricity (p. 534).

The full translation is given of an official announcement in a recent number of the *Zeitschrift für Beleuchtungswesen* of the formation of an **Illuminating Engineering Society in Germany** (p. 538). Stress is laid on the need for an impartial body of this kind which will carry to their logical conclusion the investigations of many famous German scientists. The Society was formed under the auspices of the Physikalische Technische Reichsanstalt at the request of the Institution of Electrical Engineers in Germany—a request which was strongly supported by the German Institution of Gas Engineers.

An interesting article by DR. T. LLEWELLYN (p. 541) deals with **Illumination in Mines.** Data are given respecting the light yielded by a variety of modern safety lamps, and it is pointed out that a higher illumination than that given by the old oil lamps is generally necessary. The interesting conclusion is reached that "nystagmus" (a nervous disease of the eyes) occurs much more frequently in mines in which the surroundings are gloomy and the lamps used are comparatively weak in candle-power. Towards the end of this number (pp. 578-579) will be found some remarks on four types of miners' lamps awarded prizes in the recent Home Office competition. These lamps were exhibited at the last meeting of the **Illuminating Engineering Society.**

The full account of this meeting will be found on pp. 543–48. The chief item was the **Summary of Progress during the Vacation** presented by the Hon. Secretary, MR. LEON GASTER. Reference is made to the important proceedings at the International Congress on the Prevention of Industrial Accidents in Milan; the recent reports of H.M. Inspector of Factories in Great Britain; and to the promise of the Home Secretary to appoint a Departmental Committee on Illumination. The formation of the German Illuminating Engineering Society receives notice as a most important event, and an account is given of Mr. Gaster's experiences during his recent visit to the United States.

Among other items mentioned at this meeting may be mentioned the display of specimens from MR. J. W. JOHNSTON'S collection of **Ancient Lamps.** MR. HAYDN T. HARRISON showed an ingenious new form of **Illumination Photometer,** and Messrs. Dow and MACKINNEY presented a series of slides illustrating the value of **Photography in Illuminating Engineering.** A series of boxes equipped with electric lamps and designed to show the effect of illumination from wall papers of different colours, was shown by PROF. W. C. CLINTON.

A novel departure in the present number is the special article entitled **'Light and Illumination: its Use and Misuse'** (p. 559). This is based on the primer on Illumination recently issued by the Illuminating Engineering Society in the United States. A series of recommendations on illumination, expressed in simple and concise language, is given, illustrated by a number of appropriate photographs. It is proposed to reprint this as a separate reprint from the journal.

At the end of the number will be found the usual **Trade Notes** and **Review of the Technical Press.**

The International Cinematograph Exhibition and Conference.

THE above Exhibition and Conference is to take place at Olympia, London, on March 27th–30th, 1913. It has been suggested that the Exhibition would doubtless be of interest to many members of the Illuminating Engineering Society and readers of this journal.

A letter from the Secretary of the Exhibition inviting co-operation was read at the meeting of the Society on Tuesday, November 19th, and it was requested that those who desire to take part in this exhibition and conference (either by exhibiting instruments and apparatus or by reading papers at the Conference) should send in their names to the Hon. Secretary of the Illuminating Engineering Society (Mr. Leon Gaster, 32, Victoria Street, S.W.). Particulars may also be obtained from the Organizing Secretary of the Exhibition, Mr. E. Schofield, 22–24, Great Portland Street, W.

The International Gas Exhibition.

In Commemoration of the Jubilee of Gas Engineers and Centenary of Gas Supply.

WE are informed that the National Gas Exhibition is to be held in the month of October, 1913, in the Exhibition Halls adjoining the White City, Shepherd's Bush, London, under the presidency of Mr. Corbett-Woodall.

As explained in a previous issue,* this Exhibition has been organized by a Joint Committee representing the Institution of Gas Engineers, the Society of British Gas Industries, the British Commercial Gas Association, and the municipal and private gas undertakings of the United Kingdom.

A special section of the programme is to be devoted to the Hygienic and Economic Aspects of Good and Bad Illumination. Model rooms, lighted by various methods, will be on view, and lectures delivered.

* Illu. Eng., Nov., 1912, p. 514.

Merchants' Show-Window Lighting Contest.

DURING a holiday carnival at Muncie, Ind., last year local interest in window lighting and decoration was stimulated by the award of cash prizes to the merchants making the best illuminated window displays. The Muncie Electric Light Company contributed to the fortnight's festivities by donating the energy required to operate the 10,000 decorative street lamps temporarily installed, but the window lighting contest was handled entirely by the merchants themselves, $1,500 in all being collected to defray the expenses of installing the street lamps and holding the various carnival contests. Prizes of $25, $15, and $10 were awarded to the three best lighted window displays, the selection of prize winners being made by a committee of the merchants. The Keller-Bryce Company, haberdasher, received first honours. Mr. Feltman, the shoe merchant, who earned third prize in the minds of the lay jury of awards, is an enthusiastic advocate of electric lighting on an extensive scale, and declares that electricity is the greatest advertising medium the retail merchant can employ.—*Electrical World*, September 28th, 1912.

TECHNICAL SECTION.

The Editor while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'

The Editor does not necessarily identify himself with the opinions expressed by his contributors.

Decorative Lighting at the Boston Electric Show.

BY DR. LOUIS BELL.

THE BOSTON ELECTRIC SHOW, lasting as it did for the full month of October, properly demanded much more of elaboration than would ordinarily fall to the lot of an enterprise of this kind. It required, in fact, something of the same treatment that would be accorded to the exposition buildings of an international affair.

FIG. 1.—Standard pole of Gothic design in Huntington Avenue.

FIG. 2.—One of the elaborate pylons of Gothic design at either terminus of Huntington Avenue.

Mechanics' Building, utilized by the Show, was about 600 ft. in length, facing Huntington Avenue, which runs westward from Copley Square, altogether the most important public place in the city. The building is roughly triangular in shape, and its main façade forms three connected fronts, each with its own entrance, the easternmost front being terminated by a tower, as shown in the illustration, Fig. 3.

In undertaking the lighting of the building and its approaches, the logical starting-point for spectacular illumination was Copley Square on the east, and on the west Massachusetts Avenue, Mechanics' Building lying midway between these points. The fundamental principle underlying the decoration was

the free use of coloured lights, both on the street and as an element of decoration on the building. A large part of the building front is heavily matted with ivy, which added considerably to the difficulty of installing the building decorations.

The first element to be considered was the street, which is nearly 100 ft. in width, with a central grass plot occupied by the tramway. After tentative sketching out of several plans for decoration, it was finally determined to introduce a new element in the way of flame arcs, with carbons mineralized to produce coloured light of a character radically different from that generally given to flame arcs. The standard pole shown in Fig. 1 was therefore worked out. It is of Gothic design, 30 ft. in height to the centre of the upper arc, with a steel tubular pole forming the core, and cased in wood with staff ornamentation. To avoid the unwieldy length of ordinary flame arcs a special lamp was constructed, burning short carbons, and with a mechanism as compact as possible. The uppermost lamp was enclosed in an 18-in. opal globe, and was fitted with flame carbons burning a pale green. The three suspended lamps were fitted with 12-in. opal globes and carbons burning light rose-pink. All the lamps were adjusted for about 6 amps., and were operated in multiple circuit from the regular underground service. At either terminus of the Avenue was placed a pair of elaborate pylons, also Gothic in design, 35 ft. high, and carrying thirteen flame arcs. One of these on Copley Square is shown in Fig. 2. The uppermost arc and the middle tier were trimmed with green-burning carbons, the rest being rose-pink as in the standard poles. These coloured flame arcs were placed 125 ft. apart, opposite each other, along each side of the street, except immediately on the sidewalk in front of the Mechanics' Building itself, where, on account of the building illumination, the arcs were omitted. These coloured flame arcs are not efficient as compared with the ordinary yellow or white arcs, but are still more efficient than the ordinary carbon arcs, and very gorgeous as spectacular illuminants.

FIG. 3.—Huntington Avenue at night showing Mechanics' Building.

Fig. 3 shows the effect on Huntington Avenue at night, including the Me-

chanics' Building itself, looking toward the tower at its apex, and showing both the front and the long hypothenuse on the rear. As the view shows, the building was treated on the front with outlining of the chief features, plus elaborate decoration of the tower itself, and of the three entrances. On the main façade and the tower, the window outlining was accomplished by strips

FIG. 4.—Mechanics' Building, main façade from the east at night.

sprung into the window casings and wedged into place, this being the only practicable method of dodging the ivy. The rear and the west end were draped with Elblight cable, some 2 miles of twin-conductor being used for this purpose. On the rear of the building a sign 270 ft. long, with letters 18 ft. high, was erected in skeleton construction above the roof. The lighting of the main façade was chiefly by 4 c.-p. carbon lamps, most of them in the natural colour. The special decorations were worked out in lamps of light and dark green, light and dark red, and amber, and took for the most part the form of conventionalized flower and foliage design, wrought in a close mosaic of lamps. The ordinary distance at which these decorations could be well seen from the front was so short that the usual spacing of lamps for ornament was far too wide, and therefore in the designs the lamps were packed almost as closely as the sockets could be placed upon their backing, with a very satisfactory result as regards general effect. For a similar reason the outlining on the main façade was done with lamps spaced at only 8 in. between centres. The effect of the mosaics proved to be very beautiful, and fully justified the trouble and expense incurred in their preparation.

Fig. 4 shows the main façade from the east, taken at night from the roof of an adjacent building, and gives an excellent idea of the brilliant effect produced. At times a flasher was used on the roof of the main tower, keeping the lights in shimmering revolution. This picture also shows the arrangement of the mosaic decorations about the three entrances.

Fig. 5 gives the aspect of the main façade and Huntington Avenue from the west. This, by the way, was taken on a hydrazine plate, which seems particularly well adapted for this night-work. At the left of the picture a bit of the draping on the West Newton Street end of the building is shown. Wherever the draping cables crossed they were tied together with

FIG. 5.—Mechanics' Building, main façade from the west at night.

knots of coloured lamps, as shown in the figure. Altogether, something over 35,000 lamps were used in the decorations, beside 212 of the coloured flame arcs on the street. These last proved so attractive an innovation in spectacular lighting that their use for decorative work elsewhere in the city after the close of the Electrical Show is being seriously considered.

Expert Opinion on the Manchester Street Lighting.

An interesting precedent has been set by the action of the City of Manchester, which invited Mr. Jacques Abady and Mr. Haydn T. Harrison to report upon the flame arc lighting in Portland Street and the high-pressure gas lighting in Princess Street in that city.

In their general report Mr. Harrison and Mr. Abady agree on the following points :—

1. That for all practical purposes the degree of illumination in Portland Street and Princess Street is approximately equal.

2. That, based upon the figures of costs of current and gas, &c., given us by the respective departments, the arc lamps as used in Portland Street are provided at an annual cost which is less than the gas lamps as used in Princess Street.

3. That, as a comparison between the possibilities of arc lighting and high-pressure gas lighting, the results are vitiated by the fact that the high-pressure gas lamps are giving an efficiency very much below similar lamps when properly installed and adjusted.

In addition, Mr. Harrison and Mr. Abady have issued separate reports on the subject.

Complementary Report by Mr. Haydn T. Harrison (Abstract).

This test is based upon the results in Princess Street and Portland Street as stated above. In both cases a length of street illuminated by four lamps was considered. It is added :—

An accurate comparison of two systems of street illumination naturally necessitates that the cost of producing and maintaining the light be carefully computed, all factors incidental to such cost being included, and that the relative value of the illumination resulting be accurately gauged.

The measurement of light and illumination has now become a science, the degree of accuracy of which is only limited by the personal error of the observers using the photometric instruments. Many years' experience of street photometry have convinced me that an accuracy within 5 per cent can be relied upon for direct candle-power measurements, and within 7 per cent for horizontal illumination measurements, provided only that the photometer used is correctly designed and constructed for the purpose.

Three photometers were used, one a rough portable instrument fitted with a Bunsen screen, the other two of the "universal" pattern. From time to time one of the instruments was sent up to the laboratory in London to be checked, and the accuracy is stated to be not less than 5 per cent for candle-power measurement, and 7 per cent in the case of horizontal measurements of illumination. In taking measurements, candle-power, distance, and height of lamps were noted, but special emphasis is placed on the minimum horizontal illumination in the street.

It is becoming the practice to use as the chief factor in comparing the illumination of streets to ascertain the minimum horizontal illumination at any part of the street in a plane at a height of 3 ft. 3 in. above the pavement level.

In order to arrive at the data necessary to prepare the report submitted herewith, a series of tests was conducted extending over a period two months in duration. These tests included :—

1. Photometric measurements of candle-power and illumination, which were carried out every night when the weather permitted.

2. Periodic measurements of gas consumption and gas pressure to check those as recorded by the gas meters and recorders installed.

3. Periodic measurements of electricity consumed to check the electricity meters installed.

4. Tests of the low-pressure gas lamps lighted in Princess Street after 11.15 P.M.

5. Daily and nightly inspection of the lamps, to check consumption and renewal of mantles, carbons, cleaning, repairs, &c.

In the cases of both Princess Street and Portland Street the method adopted has been the erection of central light sources suspended on span wires. In the case of Princess Street the sources of light consist of Keith high-pressure gas lanterns, each containing three inverted high-pressure mantles supplied with gas from the Corporation gas supply, raised to a pressure of 55 to 60 in. (of water) by means of a compressor plant situated in Piccadilly, the pumps of which compressor plant are driven by electric motors supplied with power from the Corporation Electricity Undertaking.

In Portland Street the same method is adopted, the sources of light under consideration in this report being the four lamps adjacent to Princess Street, which are of the Metroflame Magazine Flame Arc pattern, with clear inner globes and partially obscured outer globes.

The author has the same remarks to make regarding the comparative advantages of the method of central suspension in the case of gas and electric lamps.

The central hanging of light sources has many advantages to recommend it where powerful light units such as these are being used. The chief of these advantages are that the units may be erected at a considerable height where they do not come into the line of vision of pedestrians or drivers of vehicles using the street; furthermore, the illumination on the footpaths is much more even than when the light sources are supported by poles erected at the side of the footway. Another advantage is that poles being rarely needed for supporting the span wires, the footway is freer from obstacles to the traffic. The only serious disadvantage is the inaccessibility of the lamps. This is generally got over in the case of electric lamps by the use of lowering gear, which draws the lamp to one side and lowers it to the footpath for attention. In the case of electric lamps this has proved satisfactory (*vide* method adopted by City of London), but in the case of high-pressure gas lamps trouble with the joints is often encountered, as in Princess Street. Therefore, in cases where high-pressure gas lighting is adopted, I am of opinion that the advantages incidental to centrally suspended lamps should be waived in favour of lamps supported from brackets attached to the wall or mounted on columns, thus allowing of a permanent connexion to the gas main.

The average distance apart of the lamps was 121 ft., in the case of the electric lamps, and 107ft. in the case of the gas lamps.

The electric measurements were as follows :—

(*a*) Average candle-power at 20–25 degrees from the horizontal.

(*b*) Average candle-power at 45 deg. from the horizontal.

(*c*) Average minimum horizontal illumination derived from on the pavement.

(*d*) Average maximum horizontal illumination derived from on the pavement.

The cost of the gas lamps worked out as follows :—

	Per hour.
Gas	1·147*d*.
Candles	·1*d*.
Labour	·18*d*.
Sundries	·073*d*.
	1·5

The general synopsis of the advantages of the gas and electrically lighted streets are shown in the table on the opposite page.

Mr. Abady's Supplementary Report (Abstract).

Mr. Abady's supplementary report is comparatively short. There are also data in the form at the end of the report, analyzing the costs of gas and electric lighting presented. Mr. Abady also remarks :—

Whereas Mr. Harrison is of the opinion that it was intended that we should simply accept the costs given us by the respective Departments, and

express the light found to be obtained from the two systems on a comparable basis of either equal cost or equal illumination, I, on the other hand, am of the opinion that the intention of the reference is that we should criticize the costs if necessary, criticize the installations if necessary, and generally report upon the systems of high-pressure gas and flame arc lighting (as exemplified by the two installations) so as to guide the Corporation as to the general bearing of our findings upon extensions of either system. We have thought it better, therefore, that we should submit separate reports.

supply for public lighting purposes 3 burner high-pressure lamps at as low a cost as can the Electricity Department supply for public lighting purposes 11-ampere flame arc lamps.

4. While not suggesting that the costs given me by either Department are incorrect, they do not appear to me to comprise all essential factors, and I, therefore, do not consider that they can be safely taken as a basis in estimating for future extensions of either system.

5. I consider the whole comparison vitiated by the fact that the high-pressure gas lamps at the angles tested have an efficiency of only 27 candles

	Princess Street high - pressure gas	Portland Street arc lamps
Candle power of lamps	1.750	2,970
Number of lamps to the mile	49·34	43·6
Running costs per lamp per hour	1·5d.	0·7d. and *0·9d.
Capital costs per mile of street	£2,537	£1,569
Running cost per 1,000 c.-p. hours	0·857d.	0·236d. and 0·3d.
Cost per annum per mile equal illumination ...	£675	£254 and *£314
Minimum illumination basis of comparison ...	0·39 ft.-candles	0·5 ft.-candles
Cost per mile of street per annum (up to 11.30 P.M.) at above illumination.	£617	£254 and *£314

* After 11.30 P.M.

Mr. Abady's chief conclusions are as follows :—

I have arrived at the following conclusions, my reasons for which are set out at length hereinafter :—

1. That the lighting with high-pressure gas lamps of Princess Street, both in respect to the amount of general illumination, the quality of light, and freedom from involuntary extinctions, is better than the lighting with flame arc lamps of Portland Street.

2. That the candle-power of the arc lamps is superior to that of the high-pressure gas lamps, and that the arc-lamp figures show that they are in a state of high efficiency, while the high-pressure gas lamp figures show that the lamps are not installed or adjusted so as to obtain normal efficiency, or anything approaching it. (I wish to emphatically impress this upon the Council.)

3. That, based upon the figures of costs given me by the Electricity and Gas Departments, I am of the opinion that the Manchester Corporation Gas Department cannot (on those figures)

per cubic foot of gas, whereas it is common knowledge, and also my invariable personal experience, that the high-pressure gas lamps, when adjusted and supplied with gas at a suitable pressure, have an efficiency of over 50 candles per cubic foot, with a minimum of 40 candles per cubic foot.

6. While it appears to have been necessary, owing to the nature of the lighting source, to suspend the arc lamps 27 ft. 6 in. high from the road, I strongly criticize the similar suspension, at an approximately similar height, of the gas lamps ; and I suggest that in any extensions 2-burner gas lamps adjusted to a proper efficiency, placed on poles 20 ft. from the ground and 130 ft. apart, would give a light equal to, if not better than, the 3-burner lamps at present in Princess Street.

7. Subject to my criticism of the installation and adjustment of the high-pressure gas lamps, I consider that the tests justify an extension of both systems ; but it follows from paragraph 6 that if it is considered necessary

to suspend lamps over the tramway route 27 ft. high or thereabouts, arc lamps should be selected for this purpose.

8. I direct attention to the fact that, in the figures of costs given in the body of this report, no annual charge is added for interest and depreciation on the capital outlay for lamps or mains, but the capital expended is stated separately. Seeing, however, that arc lighting on the system employed in Portland Street requires a special main, this is a factor of cost which should not be overlooked.

9. As the tests were made in the summer, no opportunity presented itself for a comparison of the two systems during foggy weather. Any remarks under this head would, therefore, have to be based upon observation of other installations; and this the reference does not call for.

The particulars of the respective installations, full details of the data obtained, and the reasons upon which I base my foregoing conclusions, are set out as addenda hereto.

In conclusion, I wish to state that I have received the greatest courtesy and assistance from the officials of both the Electricity and Gas Departments, and have endeavoured to interpret the facts and data with absolute impartiality.

In the supplementary matter previously mentioned Mr. Abady explains his reasons for these conclusions.

Flash-Lighting Railway Signals.

A FEW months ago an exhibit of a new flash-light signal system for railways was given in London, and we have since received a reprint of a paper by E. G. Windahl, Chief Signal Engineer of the Swedish State Railway, on this subject.

At present it is customary in distinguishing light signals to use red, green, or uncoloured lights to indicate "stop," "caution," and "clear." But various colour combinations have had to be contrived as the variety of signals necessary has extended. An additional means of distinction lies in the use of flash-lighting signals, especially for indicating the main lines, and enabling these signals to be clearly marked out from those applying to slow trains and sidings. In the "Aga" system being tested on Swedish railways, flash lights for distant signals having one-tenth of a second flash and nine-tenths darkness are used; for the home and starting signals a longer period is used, so that these two classes can be readily distinguished.

In the flash-light system there is it is claimed slight danger of confusion with adjacent lights unconnected with the railway. It is also claimed that in foggy weather a flash-light signal will attract attention when a steady light could not be seen, and that a flashlight can always be distinguished from a steady one, whereas colours are apt to be confused in a mist or fog.

For flash signal lights a portable self-contained system of lighting and automatic flashing apparatus are essential. In the system described by Mr. Windahl small tubes of dissolved acetylene are used which need not contain more than about half a cubic foot of gas. A considerable saving is accomplished in the amount of acetylene used, owing to the comparatively long period of darkness; and it is also suggested that the signals could be turned off completely during the daytime when no lights are necessary. It is estimated that distant signals only require renewal about every two months, and the exchange of a new tube of dissolved acetylene for the exhausted one is very readily effected. The starting lights, having a longer flash period, would last for a somewhat shorter time. The Dalen automatic flashing device used for this class of work has already been largely employed for buoys, lighthouses, &c.

The Foundation of the German Illuminating Engineering Society.*

On November 2nd, 1912, the German Illuminating Engineering Society came into existence under the auspices of the Physikalisch-Technische Reichsanstalt in Berlin.

The importance of a recognized body representing all the interests of illumination has made itself felt in Germany for a long time. The lack of an authoritative body capable of dealing with important questions connected with illumination, such as the establishment of standards, nomenclature, and units, methods of measurement, international agreements, &c., has often been painfully experienced. Above all, it is unthinkable that international agreement on such questions could be arrived at without there being such an acknowledged society. In consequence of its non-existence, Germany, which for a long time has taken an important part in connexion with illumination, has gradually lagged behind, and in particular has been outstripped by the United States.

The interest in lighting taken by the gas industry has been exemplified in the Commission on Light Measurement instituted by the Deutsches Verein von Gas und Wasserfachmänner. The Verband Deutscher Elektrotechniker likewise attempted to standardize methods of measurement for electric lighting, and framed rules for the photometry of glow lamps and arc lamps. In individual matters, especially as regards the standard of light, agreement between the various Societies and institutions interested has been reached; especially now that the Physikalisch-Technische Reichsanstalt, as the result of its classical investigation of the Hefner lamp and the comparison of it with earlier standards used elsewhere, has made the Hefner lamp a standard for light measurement for the whole world. Nevertheless, the mutual rivalry of the chief concerns interested in lighting and the constant competition between gas and electric lighting has materially hindered the co-operation between these parties, although, for the correct understanding of many important questions, and particularly the adjustment of international problems, such co-operation is most essential. This is much to the detriment of the whole science of illumination.

Many parties which are not represented in the institutions referred to above have, nevertheless, a keen interest in the development of illumination, but hitherto have not been able to make their views felt—*e.g.*, those concerned with acetylene, petroleum and spirit lighting, the physicist, the chemist, the medical man, the sanitary engineer, the physiologist, the schoolmaster, and the factory inspector, &c. Formerly, if these specialists took any part in the discussions on questions connected with lighting, it might easily happen that their expression of opinion was regarded as "non-technical." Nevertheless, such "outsiders" are in a position to be of great assistance in deciding many important lighting questions. Moreover, either on account of the nature of their special aims and objects, or on account of their being removed from the strife of commercial rivalry, these experts would often be able to originate scientific investigations and to solve problems which, while apparently far removed from commercial matters, are nevertheless of paramount importance as regards illumination.

To Kirchoff's genius and intuition we are indebted for a knowledge of the laws of radiation, which the investigations of Wien and Planck, of Lummer, Kurlbaum, Holborn, and Pringsheim, have established and enlarged during a decade. To-day this field is still far from exhausted, and these laws are already regarded as the basis of the

* Translated from the official announcement in the *Zeitschrift für Beleuchtungswesen*, November 10, 1912.

development of illumination from purely empirical scientific data.

To the chemist Auer von Welsbach and the physicist Nernst we owe the first practical applications of such laws to modern illuminants.

To Prof. Hermann Cohn, the oculist, in conjunction with Prof. Leonhard Weber, the physicist, are due the investigations of the minimum illumination for streets, squares, schoolrooms, and private houses.

We have to thank Leonhard Weber, Lummer, Kurlbaum, Martens Ulbricht, and Krüss for apparatus which enables us to measure light with as much precision as is possible in other departments of physics. In the well-known workshops of Schmidt and Haensch and A. Krüss these investigators have found fellow-workers able to assimilate their ideas and develope them in a practical form.

The investigations of medical officers of health, school authorities, and factory inspectors have greatly aided the perfecting of our methods of lighting and their practical applications.

All these investigations have up till now stood more or less isolated, and their connexion with practical illumination was very slight. Owing to the existing publications on these subjects being sharply divided into two sections (" practice " and " theory," so called), and because of the lack of an impartial platform for the free expression of opinion for representatives of divergent interests, difficulties have arisen which are quite unconnected with the nature of the problems to be considered.

During the last year this has been made particularly evident owing to the movement originated in the United States and other foreign countries with a view to agreement on a common unit of light.

In order to remove these difficulties a request for the formation of an Illuminating Engineering Society was made to the Reichsanstalt by the Verband Deutscher Elektrotechniker early this year, and strongly supported by the Deutsches Verein von Gas und Wassenfachmänner. This appeal received ready hearing, and the Ph.T.R. immediately formed a small committee to take in hand the preliminary steps for the foundation of a German Illuminating Engineering Society. The Committee consisted of the following gentlemen: Prof. E. Warburg, The President of the Ph.T.R. Geheimer Hofrat Bunte, Herr G. Dettmar, Director Hagen of the Ph.T.R., Prof. E. Liebenthal of the Ph.T.R., and Prof. Brodhun of the Ph.T.R. By this Committee a number of prominent members of the lighting industry were called together, and the framing of the constitution of the Society was commenced. Unfortunately on account of the limited room in the Ph.T.R., the number of invitations issued was on a very moderate scale, and at the meeting many people and firms were of necessity absent whose support the German Illuminating Engineering Society could ill afford to lose.

On Saturday last the Society was established.

After the President's (Prof. E. Warburg) greeting to those present, there were short speeches from Geh. Hofrat Bunte and Herr G. Dettmar, who laid stress upon the weight and importance of the Society. The meeting chose Prof. Warburg as the chairman, Dr. E. Liebenthal as secretary, and Dr. Bunte and Herr Dettmar members of the Council.

The proposed rules for the Society were accepted with acclamation. We give the following extracts :—

" The aim of the institution is the furthering of the science of illumination both in theory and practice, and in particular :—

(1) The concentration of the efforts of various circles interested in illumination in Germany and other countries.

(2) The representation of German lighting industry in international relations."

" Members may be (1) individuals, (2) firms, corporations, and societies."

" The affairs of the Society will be conducted through :—

(1) The officers, (2) the Council, (3) members' meetings.

The Council in whose hands rests the carrying out of the practical work

and special undertakings of the Institution is to consist of twenty-four members, of whom six must always be members of the Councils of the Verband Deutscher Elektrotechnischer and the Verein von Gas und Wassenfachmänner respectively, whilst the remaining twelve must belong to other bodies interested in illumination."

"Ordinary meetings of the Society are to take place from October to May."

"The annual meeting will, in general, take place in the autumn, outside Berlin. The *Proceedings* of the Society will be published in the *Journal für Gasbeleuchtung und Wasserversorgung*, the *Elektrotechnische Zeitschrift*, and the *Zeitschrift für Beleuchtungswesen*."

The first ordinary annual meeting will take place in Berlin in February, 1913. At this meeting the ordinary officers and Council will be elected. A general paper will be presented summarizing the science of illumination, and it is anticipated that this will be undertaken by Prof. Dr. Otto Lummer.

Until the first ordinary general meeting takes place Prof. E. Warburg (chairman), Dr. E. Liebenthal (secretary), and Geh. Hofrat Bunte, Herr G. Dettmar, Prof. Brodhun, and Director Hagen will provisionally take charge of the affairs of the Society.

The foundation of the German Illuminating Engineering Society is a milestone in the path of development of illuminating engineering in Germany. Through the influence of the Society, and by the friendly co-operation of the formerly conflicting interests which it will bring about, together with the special assistance of independent experts, the movement will no longer be confined to foreign countries.

Illumination at the Coal-Face with Special Reference to the Incidence of Miner's Nystagmus.

[An abstract from the paper read by Dr. T. Lister Llewellyn before the Institute of Mining Engineers, on Oct. 21, 1912.]

THE illumination at the coal-face depends mainly on four factors: (1) The candle-power of the source of light used; (2) The distance at which the light has to be placed from the coal-face; (3) The character of the surroundings; and (4) the composition of the air at the coal-face.

1. *Candle-power of the Source of Light Used.*—There are two classes of mines: (1) Those in which open lights are used; (2) those in which safety lamps are required. In the former wax or tallow candles are used at the coal-face. The wax candle needs little attention, and remains constant during the day. The light given by it is equal to that of a standard candle, the tallow candle gives more light, but requires more attention, and does not remain constant for any length of time if left to itself. It is the custom in several districts to spread out the strands of the wick so as to obtain a large flame, sometimes as much as twice the candle-power can thus be secured.

The small oil lamps used in the main roads give from 2 to 4 candle-power, the larger lamps are used chiefly by hauliers.

The safety lamps used rarely give more than ·5 of a candle-power—a great many tested at the coal-face by Dr. Llewellyn gave less than half this result. These, however, were of the old Cambrian type. Oil safety lamps soon become dirty, and a lamp at the end of a shift may only give a third of its original light. Safety lamps at the coal-face rarely give more than a third of a candle-power when clean and much less when dirty.

2. *The distance of the Source of Light from the Coal-face.*—Candles or safety lamps are seldom placed more than four or five feet away from the coal-face. There is a tendency, when

the miner is working with a lamp, to cut coal over a large area without moving it from its first position, since the lamp requires time and care to move; the candle can be easily and quickly moved from place to place.

COMPARATIVE LIGHT YIELDED BY LAMP.

Description of colliery.	At main intake	At main return	At coal-face
Well ventilated open light colliery	1	0·8	0·8
" " safety lamp "	1	0·8	0·64
Poorly " " " "	1	0·4	0·66
Well " steam coal colliery	1	0·9	0·7

3. *Character of the Surroundings.*—

Character of mine	Light used	Nature of surroundings	Prevalence of manifest Nystagmus
Safety lamp coal pit	Poor, rarely equal to 0·5 c.-p.	Marked blackness	Common
Naked light "	Generally 1·0 c.-p.	Marked blackness	Rare
Metalliferous mine	" " "	Blackness absent	Unknown

Very little light is obtained from diffused reflection since this power is practically absent at the coal-face.

Description of colliery	Lamps used	Lamps cleaned by	Candle power clean	c.-p. after shift	Result of cleaning	Number of men employed	Number of cases of nystagmus		Remarks
					per cent			per cent	
Steam coal	Old pattern Cambrian	hand	0·235	0·22	6·2	450	9	2·0	Glass and gauze not removed. There were no proper brushes or cloths in lamp room.
" "	"	machine (owing to break-down by hand)	0·27	0·18 to 0·22	26	1,400	22	1·57	Some lamps returned by men very dirty. No attempt made by them to clean outside of glass.
"	Ackroyd & Best	machine	0·33	0·25	—	1,500	10	0·66	Lamps old, and some not well kept.
	Ackroyd & Best, chiefly some Patterson and a few Cambrian	machine	0·4	0·28	30	2,500	14	0·56	Lamps well kept.
"	Patterson	machine	0·42	0·27	35·7	1,900	8	0·42	—

The coal itself is black, the floor is covered with coal-dust; the roof, owing to the shadow cast by the bonnet of the lamp, is in darkness, while any reflection from the working surface is stopped by the back of the miner himself. The coal absorbs from 93 to 96 per cent of the incident light. It is interesting to compare this with the absorption of ores which varies from 70 to 80 per cent.

4. *The Composition of the Air at the Coal-face.*—The light from a safety lamp falls off rapidly as the *oxygen percentage* of the air diminishes; it also falls with an increase of moisture in air. *The presence of gas* up to 4 per cent increases the illuminating power of the lamp,

after this the lamp rapidly becomes dim. The following table shows the influence of bad air on the lamp :—

In the pits tested by Dr. Llewellyn the average illumination varied in *Naked Light Pits* from 0·08 to 0·14 of a foot-candle and in *Safety Lamp Pits* from 0·015 to 0·022.

The following are a few measurements of illumination present in places other than coal-face; these naturally vary considerably in different mines :—

Collier ripping top, average reading 0·0187

Collier setting pair of $6\frac{1}{2}$ ft. timbers, lamp of neck strap: average illumination 0·04 foot-candle.

Haulier spragging off in parting, lamp in hand, illumination on wheel 0·075 foot candle; shackling 0·06 foot-candle.

Repairer with lamp on neck-strap wedging top of cog in hole in roof, average 0·05 foot-candle.

Timberman notching arm 0·035 foot-candle.

Roadman cutting bottom 0·025 foot-candle.

The accompanying table contains some figures showing the relation between miner's nystagmus and amount of illumination :—

Dr. Llewellyn finds that most of the men now working in the naked light pits of South Wales had worked at one time with safety lamps. It is quite common for men to continue working in an open light pit after they have failed to work with safety lamps. Taking into consideration the number of men employed, England and Wales, using safety lamps three times more frequently than Scotland, have four times the number of cases of nystagmus:

	Scotland.	Rest of Kingdom.
Number of cases of Nystagmus	55	1563
Percentage of cases to men underground	0·05	0·21
Percentage of safety lamps used	28·2	91·6

Out of 600 consecutive cases, 591 had worked with safety lamps, and only 9 with candles alone; 23 of his cases came from open light pits, and of these 14 had worked at one time with lamps.

The following table is drawn up from results obtained by Dr. Llewellyn: 680 lamps were tested, each trimmed to the height at which it would be used at work. The pits are consecutive pits in the same valley. The first is the highest in the valley, and consequently the oldest and least up to date in the matter of lamps and ventilation :—

The following are Dr. Llewellyn's conclusions :—

The light given by the modern oil safety lamps at the coal-face is often less than a third of a candle-power, and is never more than half a candle-power.

The illumination falling on the coal-face in an open light mine is about five times the amount obtaining in a safety lamp mine.

The incidence of nystagmus in an open light pit is about a sixth of that in a safety lamp pit.

The incidence of nystagmus is inversely proportional to the amount of illumination at the coal-face.

The final conclusion is that the light given by the modern oil safety lamp is insufficient.

The following table gives briefly the relation between nystagmus and illumination.

Light	Men	Proportion of certified cases of nystagmus	Relative proportion	Average illumination at coal-face in ft. candles
Safety lamps	88 or 7·3	46	6·3	0·018 or 1·0
Candles	12 or 1	1·1	1·0	0·09 or 50

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Recent Progress in Illuminating Engineering.

(Proceedings at a meeting of the Illuminating Engineering Society held in the House of the Royal Society ot Arts (London), on Tuesday, November 19th, 1912.)

THE first meeting of the 1912–13 session was held in the rooms of the Royal Society of Arts on Tuesday, November 19th. The President, Prof. Sylvanus P. Thompson, was in the chair.

The Hon. Secretary read the minutes of the last meeting, the names of applicants for membership presented for the first time, and the names of applicants to be read a second time and declared members of the Society.*

THE PRESIDENT recalled that the report of last session had been formally accepted at the annual meeting in May, before the long vacation. Unlike most other societies, the Illuminating Engineering Society had two annual reports in the year, one a report upon the work of the session, and the other an account of the work that had been effected during the vacation, not necessarily by the Society, but in the subject which it represented, namely, that of illuminating engineering. He would therefore call upon the Hon. Secretary to present his report of what had occurred in the interim.

Summary of Progress in the Vacation.

MR. L. GASTER then presented a summary of progress during the vacation. This will be found *in extenso* on p. 551.

THE PRESIDENT thought the Society could congratulate itself and its Hon. Secretary upon the success which had attended his vacation wanderings. It was not given to all of us to be able to go almost from China to Peru to study illumination, but Mr. Gaster had been over the greater part of Europe and the United States, and had shown by his report that the objects of the Society were being prominently kept to the front, not only by himself in his travels, but by others in all those different countries which were finding, each in their own way, the same necessities and the same solutions to the problems that presented themselves.

There were now in several civilized countries the beginnings, at any rate, of an organization which would be prepared to co-operate with the Society for the promotion of good lighting. The little pamphlet which our American friends had brought out on 'Light: its Use and Misuse' would be extremely valuable and serviceable in impressing upon the public the necessity of putting their lighting in order, and, as Mr. Gaster had stated, the Society was proposing to adapt that pamphlet to our own ends in this country.

It would be observed that the Society just formed in Germany had been very largely moulded on the lines upon which the English society was founded. The English Society had been the pioneers, as an illuminating engineering society, in organizing the joint conferences and discussions with bodies such as architects, librarians, school

* See p. 549.

managers, and the like, and discussing lighting as it affects the various interests. Now that the Americans were following suit, the Germans had founded their lighting society, and other Continental countries were paying increased attention to illuminating engineering, it was clear that the English Society would find itself with plenty of opportunity for friendly co-operation.

When the Society was first founded, the question was raised whether there was enough matter to last through the first session, and whether they would not have exhausted the subject by the end of the year; but each successive session showed that the subject was widening. There was a continuous supply of important questions coming up for consideration, and the Society was now attaining to a position of greater influence with each successive year.

The fact that the British Home Office was about to appoint a Committee to look into the question of industrial lighting was a very significant one, and equally significant was the fact that such a large proportion of the report of the Chief Inspector of the Home Office last year had been devoted to the question. Also, the suggestion which had been broached by the Hon. Secretary at one of his foreign meetings, namely, that insurance companies would do well to give a rebate in favour of those establishments which were properly lighted, and where, therefore, accidents might necessarily be expected to be less frequent than in the average factory, was an exceedingly practical one, and one that would unquestionably bear fruit in the future. It was obviously to the interests of the insurance companies to diminish the number of accidents, and it was to their interests, therefore, to induce manufacturers to put the lighting of their factories in good order. All these things were evidence of sound progress on the lines desired, and would certainly tend to give the Society strength in the future to secure new members, and the co-operation of foreign members.

The names of some of their members abroad had been mentioned by the Hon. Secretary as persons whom he had met out of England. He would mention particularly the name of Mr. Doane, because it was only a year ago that Mr. Doane came to one of the meetings in London, and they had a very pleasant time with him. He knew that Mr. Doane went away impressed with the Society, convinced that it meant business, and that it was working on the right lines. Then they had a visit in the summer from Mr. Hyde, who had done so much in connexion with photometric work. Dr. Hyde went to the Continent to further this matter, and it was since his return that Mr. Gaster had met him. This was one of the things in which specific progress was being made, namely, the organization all over the world of an agreement on photometry and photometric units. They could hardly ask for discussion on Mr. Gaster's report, and he would therefore conclude by expressing the thanks of the Society to Mr. Gaster on his very successful operations during the summer.

Mr. Gaster, having read his report in abstract,

The President remarked that there were a considerable variety of topics to deal with that evening. They had listened to the work that was going on all over the world, but now they came to something very different. Mr. J. W. Johnston was the fortunate possessor of a very remarkable collection of antique means of illumination, and he had very kindly brought some specimens of old lamps, which he would describe. This communication they would not pass over without discussion, and he invited any members of the Society of Antiquaries or any other society who might be present, and who had taken an interest in antique forms of illumination, to regard themselves as members of the Illuminating Engineering Society for the evening, and to take part in the discussion after Mr. Johnston had described his lamps.

Ancient Forms of Lamps.

Mr. J. W. Johnston said that when Mr. Gaster and Mr. Dow very kindly

asked him to be present and bring a few of his lamps and say a few words about them, he rather hesitated, inasmuch as his collection was fully and ably dealt with in the articles and excellent photographs which appeared in the August and September numbers of *The Illuminating Engineer*. He had occasion a little while ago to give a lecture at Hendon on the subject of light from the earliest times, in aid of a scheme in which he was very deeply interested. Mr. Waldram, a member of the Society, mentioned the matter to Mr. Gaster, who expressed a desire to be present. Since then Mr. Gaster had drawn him out of his seclusion. The article in *The Illuminating Engineer* was the first result, and he was now delighted to bring his collection to the notice of the Society. It was a good thing to have a hobby, and for a man engaged in professional life or any business in the hurry and scurry of the City of London to be able occasionally to turn his attention to some entirely different subject. Any of those present who were Freemen of the City of London knew that when they took up this Freedom of the City they were presented with a small gift-book entitled 'Rules for the Conduct of Life,' and in this small gift-book rule 33 said: "Take some proper times to relax your thoughts from business, that you may be better able to return to it. A heavy load constantly borne without intermission will waste your strength, and make you unfit for everything."

Mr. Johnston then proceeded to describe some of the ancient lamps exhibited, which included specimens from such remote countries as China, Korea, and North Borneo.* The thing that would at once strike any one interested in illumination was the fact of many of these lamps remaining essentially the same for hundreds and even thousands of years. What a contrast to the progress in lighting during the last twenty years! On the other hand, many of these lamps were beautifully proportioned and embellished, and would doubtless furnish useful hints to the designers of fixtures of to-day.

Mr. F. W. Goodenough said he felt sure it would be the wish of all present to pass a very hearty vote of thanks to Mr. Johnston for his kindness in bringing specimens from his wonderful collection of ancient lamps to the meeting. It was a very extensive collection which he possessed, and the consideration of it certainly helped to carry one's mind away from everyday work, because there were few things further removed from present methods of illumination than some of the specimens they had seen.

Dr. A. H. Levy briefly seconded the vote of thanks.

Mr. J. W. Liberty, in supporting the vote of thanks, referred to a lamp in the museum at the Guildhall. Not only were there several Roman cruisie lamps, but there was one of the best collections of Roman lamps and Roman British lamps, all of which had been dug up from beneath the streets of the City of London and deposited in the Guildhall. He might also refer to the centrally hung lamps, which were a feature in the early days of public lighting, and were now coming back again. Lanterns containing candles were hung across the streets, and it was the duty of citizens to keep the lamps burning.

Mr. W. M. Mordey asked if the author was certain of the derivation of the word "peermen." It occurred to him that there might be another explanation of the word, which had to do with seeing rather badly. With regard to the word cruisie, it would be interesting to know whether that had anything to do with the Scriptural word cruse of oil. Seeing these lamps rather increased one's sympathy for the maidens read of in Scripture, who were blamed for not having trimmed their lamps. When one saw what very inadequate provision was made for the supply of oil, one could not help feeling that they were not as blameworthy as we were taught when we were young.

Dr. Hickman asked whether some scientific member of the Society had measured the candle-power of the

* See *Illum. Eng.*, Lond., Aug. and Sept., 1912.

stone cruisie, and the nature of its distribution of light.

Mr. JOHN DARCH asked if anybody could give a reason why, through a period of some twenty centuries, people got no further than using oil and wicks, and that we had to wait until the nineteenth century before we came to anything like good lighting.

THE PRESIDENT expressed his personal thanks to Mr. Johnston, and his extreme appreciation of the opportunity of seeing the specimens which were on view.

MR. JOHNSTON said it had been a great pleasure to him to bring the specimens. With regard to the derivation of the word "peermen," the pronunciation was due to the difference in Scottish dialect. Undoubtedly it was originally "poormen." In other districts in Scotland it would be "puirmen," but in Aberdeen the pronunciation was "peermen." There was no doubt about it that that was the derivation, for it was only two years ago that he came across a very old farmer in Scotland who remembered his grandfather having these men and keeping them all night and buying up their stock for the winter for his lamps. The word cruisie was derived from the Biblical word cruse of oil.

MR. R. J. WALLIS-JONES, who then took the chair, the President having another engagement, called upon Mr. Haydn T. Harrison to describe his new illumination photometer.

A New Illumination Photometer.

MR. HAYDN T. HARRISON said that he had been engaged in photometric work for many years, especially in connexion with street lighting, and had frequently experienced the need for a photometer which would read very low illumination.

This instrument, which was described as the "lightometer," consisted in a light proof-box containing a small standardized tungsten lamp at one end and a Bunsen screen at the other.

Mounted on one side of the box is a sliding Rheostat connected in series with the Standard Lamp, and provided with a pointer indicating on the scale the illumination of the screen in foot-candles.

The photometer can be presented at any desired angle, and the observer has only to adjust the pointer until the spot on the Bunsen screen disappears. The pointer will then indicate the illumination. It will be observed that the adjustment was carried out entirely by varying the resistance, the lamp being stationary. This, Mr. Harrison explained, gave a very convenient form of scale, which could be reproduced quite closely for different instruments. There were two scales, one reading from ·3 to 10 foot-candles, the other from

General View of the Lightometer.

·001 to ·3 foot-candles, corresponding with the application of 4 volts and 2 volts respectively to the standard lamp.

By looking at the scale from the outside one measured illumination in the ordinary way. But it had been shown, in the valuable work by Mr. Dow and Mr. Mackinney with their Holophane Lumeter instrument, and by others, that it was also useful to determine the actual brightness of distant surfaces. He had, therefore, arranged for this to be done with the "lightometer." A small hole was

pierced through the centre of the Bunsen disc, and there was also an eyepiece in the side of the instrument; by looking through this eyepiece one saw the inner side of the illuminated disc, and, through the hole in it, any distant object whose brightness it was desired to test. By adjusting the photometric balance the surface brightness could, therefore, be obtained in the ordinary way.

One point which would doubtless have been raised by Mr. Trotter, had he been present, was the question of the shininess of the Bunsen screen, and whether it would follow the cosine law. He had found that, within fifteen to twenty degrees, the variation was within 2 per cent.

As an illustration of the use of the instrument, Mr. Harrison measured the horizontal illumination in the room, which he stated to be about ·85 foot-candles. By having the lights in the room extinguished, he also showed how the instrument could be applied to measuring very weak illuminations.

If desired, provision could be made to equip the instrument with an ammeter for reading the current.

The Chairman expressed the indebtedness of the Society to Mr. Harrison for describing the new instrument, and a hearty vote of thanks was passed on his proposal.

Photography in Illuminating Engineering.

Mr. J. S. Dow then showed some slides illustrating the value of photography in illuminating engineering. His excuse for bringing this point forward at the beginning of the Session was, that he felt that in illuminating engineering the question of illustrations and photographs was a very vital one. After all, what we were all concerned with in illumination was the effect of light on the eye, and, therefore, whenever we described any installation, we were only trying to get a word-picture of the installation. It was very often the best plan to show a person a satisfactory photograph which would enable him to see at a glance much that could not readily be explained in words.

At the same time, the production of really accurate photographs by artificial light was an extremely difficult matter. When, about five years ago, he first became associated with *The Illuminating Engineer*, he was struck by the great difficulty in getting good illustrations, and also with the fact that so very few people seemed to have any idea of how to take photographs by artificial light. There was very little information available as to what the exposure ought to be, or how to allow for the actinic values of the different kinds of light. Therefore, he took up the question with Mr. Mackinney, and the photographs he would show were really due almost entirely to Mr. Mackinney's skill. Wherever photographs were taken, it was usually also necessary to make measurements of illumination, and they had thus come to recognize how conveniently photometry and photography could work hand in hand. They used an illumination photometer to measure the brightness of objects in the field of view, in order to judge the exposure, and some of the results obtained were described in a paper read before the Royal Photographic Society a little more than a year ago. The same method had been used by Mr. Ritchie, who had done a great deal of work on this subject.

The two chief essentials in a good photograph of an installation were, *firstly*, that the room should appear exactly as it really was by artificial light; and, *secondly*, that the positions and natural appearance of the fixtures, shades, and glassware should be shown without distortion and halation. These were things which early photographs by artificial light did not do. Such photographs usually showed the lamp with a perfect blaze of fog round it, making the details indistinguishable. Moreover, owing to incorrect exposure and development, the room not infrequently was made to look very dismal when it was in reality very well lighted. It was only by determining exactly the right exposure, and arranging the conditions of development very carefully, that it was possible to get just what was wanted in these respects. It was

also necessary to remember that the total range of brightness in a finished print was not much more than 30 to 1, but, of course, there was often a far greater range than this in the actual objects. Much judgment was needed to decide what were the essential parts of the picture that must be reproduced exactly. There were a number of complicated technical questions involved in securing sharp images of illuminated light sources free from halation. Even when the edges appeared sharp, it appeared almost impossible to get all the detail in an illuminated globe or reflector (*e.g.*, to show all the illuminated prisms in a Holophane reflector), and yet to bring out the illuminated objects in the room as well. For scientific purposes it was usually desirable to avoid retouching as far as possible.

He himself thought that the ideal way to preserve a record of lighting installations was to have two things; a really good photograph, showing the actual installation as it appeared to the eye, and data on intensity of illumination prevailing.

Mr. Dow then exhibited and explained a number of slides showing photographs taken by artificial light. Many of these referred to shops, banks, offices, &c. It was explained that only in two cases had there been any retouching, and this was rendered necessary by the fact of so many moving vehicles with headlights crossing in front of the camera, and causing streaks on the negatives.

Another development which he and Mr. Mackinney had recently been attempting was to introduce figures of people into the photograph. A view of an empty room was obviously not so satisfactory as one in which people were shown at work. The difficulty was that the exposure by the light of incandescent gas or electricity could not easily be made very short. It seemed doubtful whether we could take genuine snapshots, except in extremely brightly lighted rooms, but the conditions were more favourable in this respect when such illuminants as the arc light and the Moore Vapour tube were used.

On the motion of THE CHAIRMAN a vote of thanks was accorded to Mr. Dow for his contribution.

The next item on the programme was an exhibition of several types of mining lamps which had been awarded prizes in the recent Home Office Competition.

Apparatus to illustrate Reflection from Walls and Ceiling.

PROF. W. C. CLINTON was then called upon to exhibit a series of boxes intended to show the effect of reflection from wallpapers of different colours. A series of cardboard boxes, each containing an incandescent lamp of the same candle-power, were lined with different-coloured paper. An aperture was cut in the side of the box and lined with translucent paper, and the brightness of this was an indication of the total illumination inside the box. Prof. Clinton explained that this brightness consisted of two portions: (*a*) direct light from the lamp, (*b*) reflected light from the paper. It was noticeable that the brightness of the aperture was much greater in the case of the box lined with light-tinted material, and the colouration due to reflection from the red and orange papers was most pronounced. In the case of one box lined with dark blue paper, it was interesting to observe that, not only was the illumination less, but the aperture appeared white in colour because the reflected blue light was of comparatively feeble intensity.

A vote of thanks was accorded to Prof. Clinton, and the HON. SECRETARY then proceeded to read out a letter from the Secretary of the International Kinematograph Exhibition, to take place at Olympia next year, in which the co-operation of any members of the Society interested in this subject was invited. (An announcement of this Exhibition appears on p. 530.)

In conclusion THE CHAIRMAN announced that the **next meeting** would take place at the Royal Society of Arts on **Tuesday, December 3rd,** when a paper on the **'Relative Merits of Direct and Indirect Lighting'** would be read by **Mr. F. W. Willcox** and **Mr. H. C. Wheat.**

New Members of the Society.

THE names of the applicants for membership, read out at the previous meeting on May 14th,* were formally announced for the second time, and these gentlemen were declared Members of the Illuminating Engineering Society. In addition the names of the following gentlemen have been duly submitted and approved by the Council, and were read out by the Hon. Secretary at the meeting of the Society on November 19th :—

Hon. Member—

Pontiggia, Luigi,	Directeur de l' Associazione degli Industriali d' Italia per prevenire gli infortuni del lavoro, Milan.

In consideration of valuable services as president at the first International Congress for the Prevention of Industrial Accidents held in Milan, May 27–31, 1912.

Ordinary Members—

Bevington, S. A.	Lighting Engineer to the Blackman Export Co., Ltd., The Haven, Grove Park Road, Grove Park, Lee, S.E.
Blok, A. *B.Sc., A.M.I.E.E.*	Lecturer in Electrical Engineering, Croydon Polytechnic, 17, Epsom Road, Croydon, Surrey.
Brereton, Mrs. M. A. Cloudesley,	Author, Editor of *The Gas Bulletin*, 7, Cannon Place, Hampstead.
Burgess, A. E. C., *M.I.E.E.*	Electrical Engineer, 13, Royal Exchange, Bridge Street, Sydney.
Bytham, W. H.	Electrical Engineer, Canadian Union Electric Co., 9, St. Nicholas Street, Montreal.
Crowley, J. F. *B.A., M.Sc., A.M.I.E.E.*	Electrical Engineer, Messrs. Siemens Bros., Ltd., 196, Deansgate, Manchester.
Davidson, T.	Glass Manufacturer, Team's Glassworks, Gateshead, Newcastle-on-Tyne.
Deladrière, L.	Directeur de l'Association des Industriels de Belgique contre les accidents du travail, 38, Rue de l'Automne, Brussels.
Elworthy, H. S. *F.R.C.S.*	Surgeon, Inspector of Injured Workmen to the Ebbw Vale Steel Iron and Coal Co., Ltd., Ebbw Vale, Mon.
Jacoby, H. A.	Messrs. Krupka & Jacoby, 11, Queen Victoria Street, London, E.C.
Jones, L. E.	38, Bedford Court Mansions, Bloomsbury.
Krupka, O.	Messrs. Krupka & Jacoby, 11, Queen Victoria Street, E.C.
Lundberg, G. C.	Manufacturer of Electrical Accessories, Pioneer Electrical Works, 477–487, Liverpool Road, London, N.
Macfarlane, M.	Incandescent Oil Lamp Manufacturer, 35, King's Avenue, Muswell Hill, N.
Maurice, G.	The General Electric Co., Ltd., 67, Queen Victoria Street, E.C.
Morrell, R.A., *M.R.C.S., L.R.C.P.*	Ophthalmic Surgeon, 13, Harley Street, W.
Tamson, A. W. K.	Gas Engineer, 3, Nieuwe-Schoolstraat, The Hague, Holland.
Wearing, A. B.	Electrical Engineer, Managing Director of the Canadian Union Electric Co., Ltd., 9, St. Nicholas Street, Montreal.

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* *Illum. Eng.*, London, June, 1912, p. 322.

Wallis, F. E.	Architect, 346, Fourth Avenue, New York City.
Walsh, B. P. K.	123, Queen's Road, Finsbury Park, N.
Yates, H. J., *F.C.S., M.I.M.E.*	Chairman and Managing Director of John Wright and Eagle Range, Ltd., Essex Works, Aston, Birmingham.

Corresponding Members—

Ashe, Prof. S. W.	Engineer and Professor, General Electric Co., Harrison, N.J.
Bocquet, J.	Chief Engineer de l'Association Normande pour prevenir les Accidents du Travail, 26, Rue Jeanne d'Arc, Rouen.
Halbertsma, N. A.	Electrical Engineer, Technical Adviser to Messrs. Tauber (Wiesbaden, Germany), Projection Arc Lamp Manufacturers, 20[1] Riedlingerstrasse, Darmstadt, Germany.
Massarelli, Ing. F.	Chief Inspector of the Associazioni degli Industriali d'Italia per prevenire gli Infortuni sul Lavoro avente Sede in Milano, 61, Foro Bonaparte, Milano.
Motais, Dr.	Secretary du Comite Technique de l'Eclairage Natural et Artificiel, 8, Rue St. Laud, Angus.
Nuel, Dr. J. P.	Professor at the University of Liège, 28, Rue Louvreux, Liège.
Seidener, J.	Secretary of the Institute of Electrical Engineers in Austria Hungary and Editor of *Elektrotechnik und Maschinenbau*, Vienna.
Steiner, V.	Editor of the *Zeitschrift für Gewerbe Hygiene*, 18, Am Tabor, 11/1, Vienna.
Steinmetz, Dr. C. P.	Chief Engineer of the General Electrical Co., Schenectady, N.Y., U.S.A.
Tolman, W. H.	Director of the American Museum of Safety, 29, West 39 Street, New York.
Whitney, Dr. W. R.	Director of Research Laboratory, General Electric Co., Schenectady, N.Y., U.S.A.

The Eighth International Congress of Applied Chemistry.

THE inaugural meeting of this Congress took place at Washington, U.S.A., last September, the delegates and members being received by the President of the United States at the White House. Dr. R. Lessing, who was present as a delegate of the Illuminating Engineering Society, reports that the proceedings were of great interest.

At the subsequent meetings many important questions were discussed, such as the determination of moisture in coal and other minerals, and the standardization of methods of detecting the same. It may be added that Dr. Lessing presented a paper on a new Coking Test recently advocated by him in connexion with fuel and asphalts, and it is gratifying to find that the United States Government Laboratory of the Bureau of Mines has already adopted this test.

Subsequently trips through the United States were arranged for members of the Congress, in the course of which the Pittsburg coal and iron district and the Government laboratories dealing with fuel and refractory materials proved of special interest. Natural gas is available in this district, and simplifies furnace construction considerably.

In the course of this meeting Dr. R. Lessing had an opportunity of meeting the Secretary and a number of officials and members of the American Illuminating Engineering Society, to whom he tendered greetings from the Illuminating Engineering Society in this country.

A Summary of Progress during the Vacation (May-November, 1912).

By Leon Gaster (*Honorary Secretary.*)

[Presented at a meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts (John Street, Adelphi, London) on Tuesday, Nov. 19th, at 8 p.m.]

This being the opening meeting of our new Session, a few words may be said on what has taken place during the vacation.

I propose chiefly to give an account of my experiences during the recent visit to the Continent and to the United States, but before doing so I may, perhaps, commence by saying a few words on what has taken place in this country.

Joint Committees on School and Library Lighting.

These Committees have held a number of well attended meetings during the vacation and have done a considerable amount of work, although not yet in a position to present a formal report. In both cases the first step taken by the Committee was to draw up a list of points on which further information seemed desirable. The Committees then proceeded to consider each of these headings in turn. In the case of school lighting it was thought advisable to divide the subject into two parts—natural and artificial lighting. Artificial lighting has received almost exclusive attention so far, but it is hoped to deal fully with daylight later on.

Among the subjects discussed by both Committees have been the provision of sufficient illumination for reading, the kind of lighting best suited for various classes of work, and the best methods of avoiding glare. It is hoped very shortly to fix, tentatively, the desirable illumination for different classes of work.

The provision of sufficient illumination and the avoidance of glare appear to be of special importance in school lighting. The Committee have embarked upon a special series of tests in order to gain direct practical experience on these matters. By the courtesy of Dr. Clay, various forms of shades have been fitted up and examined in a classroom at the Northern Polytechnic. The illumination on the desks and the blackboard has been adjusted experimentally, and measured in order to ascertain what the desirable intensity should be. The Committee have now reached the stage of drafting a tentative series of recommendations, and it is proposed to equip two schoolrooms completely with gas and electric lighting, making them model installations, before presenting the actual conclusions on which they are based.

Industrial and Factory Lighting.

Since the last meeting of the Society the report of H.M. Chief Inspector of Factories for 1911 has been issued. During the last few years it has been very gratifying to observe how the attention given to illumination has increased. But the 1911 report constitutes a "record." No fewer than thirty-eight pages (about 12 per cent of the total space in the report) are devoted to illumination. The chief feature is the special sectional report by Mr. D. R. Wilson, giving the results of over 2,500 measurements for illumination in factories, comprising the results of tests made at 125 works.

The report itself has been summarized in *The Illuminating Engineer*. It is only necessary to point out the great influence which this action of the Home Office must exert for the improvement of lighting conditions, and especially the recognition it affords of the value of actual measurements of illumination. I understand that the new Indian Act relating to factories

contains specific reference to illumination, so that in deciding points that arise in that country illumination data of a valuable description should be collected.

The Departmental Committee on Illumination.

The interest taken by our Society in industrial lighting has already led to one most important announcement. In reply to a question put by Mr. Arthur Lynch in the House of Commons on May 16th, the Home Secretary promised to appoint a departmental committee on illumination, with special reference to industrial lighting. It will be recalled that a committee on the Hygienic Aspects of Illumination has been appointed by the French Government, and is already doing useful work, and we hope that the committee in this country will be appointed very shortly.

The emphasis placed on measurements of illumination in factories leads me to refer to evident growth of interest in apparatus of this kind. During the vacation quite a number of new photometric instruments have appeared, and their industrial value is certainly much better appreciated than it was a few years ago.

The Optical Convention.

The Optical Convention was remarkable for several new departures. In the first place, illumination formed an integral part of the exhibition. Besides the display of optical instruments, various forms of illuminating glassware, shades, and reflectors were exhibited, the idea being to bring home the practical application of the laws of optics in illuminating engineering.

Another feature was the attention given to photometry A number of new instruments for measuring illumination was shown for the first time, and—what is more important—such apparatus was shown in conjunction with the lamps and reflectors it was intended to test. For example, in many cases there was exhibited side by side forms of reflectors, the characteristic polar curves of light distribution derived therefrom, and the apparatus used in obtaining these curves.

It was also interesting to note that the apparatus for distributing the light was regarded as distinct from the illuminant. Shades and reflectors for use with gas and electricity were shown side by side, and it was thus demonstrated how much there is in illuminating engineering which is common to all illuminants.

I may add that a most instructive Presidential Address was delivered by Prof. Silvanus P. Thompson, in which a tribute was paid to the valuable work being accomplished by the Illuminating Engineering movement.

Lectures on Illuminating Engineering.

I am glad to say that the lectures on Illuminating Engineering arranged to take place at the Polytechnic (Regent Street) are being continued this year, and we may hope that this course will eventually become a regular feature. As on previous occasions, the various subjects in the course will be dealt with by specialists, all of whom are members of our Society. I would like to draw special attention to this course, and hope that members of the Illuminating Engineering Society will all give their support and make it a success.

The Illumination of Mines and Miners' Lamps.

The question of illumination in mines is also exciting much interest. Authorities have been concerned by the development of a nervous disease of the eyes known as Nystagmus, which appears to be partly due to working by a very feeble and flickering light, as is yielded by the more old-fashioned types of miners' lamps. This matter, it may be recalled, was the subject of several papers at the Brussels Congress in 1910. The point was also raised in the House of Commons by Mr. Arthur Lynch, probably in a question addressed to the Home Secretary, and it was stated that an inquiry was now being held. A number of researches have been conducted in England with a view to finding out what are the exact conditions responsible for the disease. In a paper read by Dr. T. L. Llewellyn before the Institution of Mining Engineers, on

October 21st, some striking conclusions are reached, the disease being proved to be unknown in metalliferous mines, where the surroundings are comparatively light, and the candle-power of the lamps high, and most marked in the blackness of safety lamp coal-pits. At the Opthalmological Congress at Oxford this year, Dr. Ellworthy likewise gave the results of a series of tests of the illumination of different mines, leading to substantially the same conclusions, which seems good ground for believing that illumination is an important factor.

Apart from this specific disease, every one must recognize that the lighting of mines, in which such a large section of the population of the British Isles is employed, is an important matter. The work in such dreary and sombre surroundings must naturally be prejudicial to health unless proper precautions are taken, and the best artificial lighting available in the circumstances should be provided.

The Home Office Prize for the best Miners' Lamp.

The importance of this matter led the Home Office to offer prizes to the value of £1,000 for the best form of miners' lamp which should comply with certain specified conditions. Undoubtedly this competition has given a stimulus to the design of these lamps, and a number of the specimens which were awarded prizes are on exhibition here to-night. A similar competition has since been promoted in Germany.

Visit to the Continent.

Let us now pass on to the visit to the Continent. My way to Milan lay through Paris, where I had an opportunity of meeting several of our distinguished Corresponding Members and others interested in our work, including Prof. Blondel, Mons. F. Laporte, and M. Janet. I had also a conversation with Prof. Langlois, who was prominently associated with the Brussels Congress in 1910, and has since taken a keen interest in our work. Several members of the French Government Commission, including M. Vacquerie, Dr. Broca, and Prof. Gariel, were also anxious to hear how the movement is progressing in this country, and I understand that the French Commi[illegible] has embarked on a most useful course of work.

Illumination and the Prevention of Industrial Accidents.

Members of the Society will recall that last year a noteworthy report on the prevention of accidents in factories was issued by a Departmental Committee appointed in this country. This, too, contained special reference to illumination, a number of questions being put to the witnesses with a view to tracing a connexion between defective lighting conditions and the frequency of accidents.

This same subject was taken up at the important Congress for the Prevention of Industrial Accidents, held in Milan at the end of May. At this Congress I had the privilege of being present representing the Society, and I can assure the members that the visit was fully justified by results. The Congress was a very important one, being under the patronage of the King of Italy, and receiving Government support. About 450 delegates and members were present—representatives of various governments, insurance companies, and important industrial undertakings. A number of interesting papers on such subjects as the removal of grit and fluff from workrooms, such as might be prejudicial to the lungs of employees, the effect of an atmosphere saturated with steam and water vapour, the fencing of centrifugal machinery, means of ensuring good ventilation in workrooms, &c., were presented, and I myself had the privilege of reading a paper on the value of good illumination as a means of preventing accidents. The paper has been extensively quoted both in the British and Continental Press, an encouraging sign that this is a live subject. A paper on illumination, by Mr. V. R. Lansingh, on behalf of the American Illuminating Engineering Society, was also presented to the Congress. One of the points that specially struck those present was the suggestion that, in the inquiries now proceeding, inspectors should make a practice of noting the conditions of illumination

whenever an accident occurs, so that we may eventually obtain data, tracing cause and effect. Another suggestion was that insurance companies should recognize the value of good illumination as regards safety and immunity from accidents by granting specially favourable rates to those whose premises comply with a certain standard of good lighting. Special stress was laid on the importance of good illumination in the case of dangerous machinery.

A number of the delegates at the Milan Congress have become Corresponding Members of the Society, as in the case of the International Congress held in Brussels two years ago. The Society may congratulate itself on having still further widened its influence, and we cannot doubt that this continuous effort to interest the authorities in various countries in illumination must bear good fruit later on.

On my subsequent return from Milan I passed through Brussels, where I had again the pleasure of seeing, among other prominent well-wishers of the Society, Dr. A. Moeller, one of our Honorary Members, and Past President of the International Congress on Industrial Hygiene held in Brussels in 1910, and Dr. Rene Sand, one of our corresponding members, who have promised to bring the question of promoting a Government Commission on Illumination before the authorities in Belgium. We have since been fortunate in also securing the support of Dr. Nuel, of Liege, who has been instrumental in drawing attention to our work on illumination. I hope that such a commission will be formed, and that a similar step will ultimately be taken in other countries. All these commissions should be able to work in harmony and keep in constant touch with each other. I think you will agree that if this piece of work can be carried through it will be in itself a great encouragement to the Illuminating Engineering movement.

I also took the opportunity of visiting Berlin during my return from Milan, and, as a member of the Council of the Electrotechnischer Verein of Berlin, I was also present at the twentieth annual meeting of the Verband deutscher Elektrotechniker in Leipzig. During these visits I met many of our distinguished Corresponding Members, including Prof. Dr. Ulbricht, Prof. Dr. Budde, Prof. Teichmuller, Prof. Wedding, Dr. L. Bloch, and others.

The German Illuminating Engineering Society.

During my visit I had many instances brought before my notice of the desire for a society to deal with lighting matters similar to our own, and in the course of conversations with those interested in this matter was able to give what, I hope, were useful particulars regarding the movement in this country. While in Berlin I learned that a request had been forwarded to us from Dr. Hagen of the Reichsanstalt, asking to be furnished with full particulars of the rules and constitution of our society. I accordingly took the opportunity to pay a visit to the Reichsanstalt, where, at the request of Dr. Brodhun and Dr. E. Liebenthal, I gave them a very full account of our work. At that time the project of forming a German Illuminating Engineering Society was being considered, and our experience was naturally of great value in suggesting the *modus operandi* and indicating lines of co-operation between the two bodies. I had also a long interview with Prof. Dr. Drehschmidt, representing the gas interest, and he promised to give the proposed German Society his assistance and support.

The official announcement of the starting of the Society has just been made. The methods to be adopted closely resemble those worked out in this country, and it will come as a revelation to many people to see how the gas and electrical interests are prepared to work together for the common good.

It was considered desirable that the first move should come from some source independent of any illuminant, and the Reichsanstalt (the Government laboratory in Charlottenburg, corresponding with the National Physical Laboratory in Great Britain) was accordingly approached on the subject.

A committee to settle the preliminaries, of which Prof. Warburg, Director of the Reichsanstalt, is the President, Dr. E. Liebenthal acting as Secretary, has been formed. The Committee receives the assistance of Herr Dettmar, Secretary of the Verband deutscher Elektrotechniker, and Dr. Bunte, Secretary of the Verein für Gas und Wasserfachmännern. The *Proceedings* of the Society will be published in the *Zeitschrift für Beleuchtungswesen*, the *Elektrotechnische Zeitschrift*, and the *Journal für Gas und Wasserfachmännern*. The first meeting of the Society is to take place in February.

To us in this country this event comes as a gratifying confirmation of the value of the movement. We naturally wish the Illuminating Engineering Society in Germany every success, and will be glad to co-operate in the good work it will doubtless accomplish.

A Visit to the United States.

At the end of the last Session I was entrusted with the duty, while visiting the United States, of conveying to our friends in that country a message of goodwill and expressing our desire for further co-operation. The movement has now reached a most interesting stage. An Illuminating Engineering Society having now been formed in Germany, we are likely to see striking developments both in Europe and America during the next few years. We have come to a point at which the fundamental rules of good lighting are becoming crystallized, and an effort should be made to reach the general public. It is, therefore, a most important thing for all of us to agree on a common policy and present a united front.

The NELA Works at Cleveland, Ohio.

Let me say, in the first place, that nothing could have been kinder than the attention shown to me in the course of my visit.

One of my first steps was to pay a visit to Cleveland, Ohio, where the "Nela" Works and Laboratory of the General Electric Company (formerly known as the "National Electric Lamp Association") are situated. Here I met Mr. S. E. Doane, Dr. E. P. Hyde, Dr. Luckiesh, and others of our Corresponding Members, and had an opportunity of seeing the magnificent works and laboratory which the Company has erected. The expenditure on research has been very generous, and the welfare of the employees of the Company is cared for in a very detailed and elaborate manner. There can be no question that the vast organization of the General Electric Company has been in many respects very beneficial to the electric lighting industry in the United States. It has enabled lamps to be easier standardized, and has brought about a common policy in lighting matters between the electricity supply companies and the lamp makers. In the space available I cannot make reference to many able members of the Company whom I met on this occasion, but I should like to mention Mr. F. S. Terry and Mr. B. G. Tremaine, who together form a wonderful business combination, and have done such a great deal towards the success of this organization. I have here an admirably got-up booklet entitled 'Developing an Industry,' which traces the progress of the "National Electric Lamp Association." I can hardly give an adequate idea of its contents here, but I should like to quote the words with which the volume opens —words which must appeal to the illuminating engineer.

"The old idea that business is warfare, and the later notion that a big business is inherently greedy and even dishonest, are both dying out. The country is waking to-day to the realization that the greatest success and prosperity lie in business co-operation, and that this co-operation must exist, not only among manufacturing interests, but also must extend in unbroken chain from the manufacturer to his distributor, and thence to the ultimate consumer."

Co-operation with the American Illuminating Engineering Society.

Subsequently I returned to New York, where I had an opportunity of seeing Mr. L. B. Marks, Dr. Sharp, Mr. P. S. Millar, and others whose names will be well known to those in

this country interested in Illuminating Engineering. I had conversations with the past and present President of the Institution of Electrical Engineers, and its genial secretary, and with Dr. A. H. Elliott and others prominently connected with the gas industry. I also met several influential members of the New York Senate who I was able to interest in the hygienic aspects of illumination.

On August 1st a special meeting of the American Society was called, and was presided over by Mr. G. E. Stickney, the Chairman of the New York Section. I took the occasion to assure our friends in the United States of the desire of this Society for mutual cooperation, and gave an account of some of the chief results that we have so far been able to bring about. The record of the work we have been able to do in such a comparatively short time was much appreciated by those present. They were specially struck by the formation of the French Government Committee, by the Home Office having taken up the subject of factory lighting in such an energetic and enterprising manner, and by the news that the Government in this country proposed shortly to appoint a Departmental Committee to deal with illumination. It was explained that the United States was in some respects at a disadvantage, since each State had its own officials and legislation. Consequently, in soliciting attention for industrial lighting, it was necessary to approach people time after time. Any measures which we can take in Europe are, therefore, eagerly awaited in the United States, since they afford a precedent which will doubtless influence the authorities in their country.

There also seemed to be a general impression that our Society, in seeking to interest the users of light by presenting Illuminating Engineering in a popular manner, had adopted a sound policy. Our discussions on shop, school, and library lighting were spoken of with special approval, and it is probable that this policy of continually trying to interest outside bodies will be followed more closely in the United States in the future.

Among others whom I met in New York I should like to mention Prof. Chandler and Mr. Whitaker, the eminent chemist of the Welsbach Company.

The Museum of Safety in New York.

In passing, I may also mention that I visited the American Museum of Safety in New York, so ably conducted by Dr. and Mrs. Tolman. The Museum is excellently equipped, but the housing is at present inadequate. I understand that the unselfish work of Dr. Tolman is to receive fuller recognition at the hands of the authorities shortly, and also that a section dealing with illumination is to be added.

It is interesting to mention that the Home Office in this country have just decided to erect a museum of safety on similar lines, and it should be the duty of our Society to see that illumination receives a due share of attention.

An Interview with the 'New York Times.'

After delivering the address before the New York section of the Illuminating Engineering Society I was honoured by a visit from a representative of *The New York Times*, who expressed his interest in illumination, and had a long interview with me. The result is shown in the copy of this paper which I have with me. Nearly a whole page is given up to this conversation on Illuminating Engineering, arranged in a popular and readable style. Considerable credit is due to the interviewer for the attractive way in which he has put the case for good illumination. When I mention that a full page in this journal is worth several thousand dollars, you will see the importance that is attached to this subject. In this country a great deal of money has recently been spent in advertising campaigns on lighting. I mention the above instance merely to show that there is a real demand for information on lighting provided it is genuine and is presented in an attractive manner.

'A Primer on Illumination.'

One enterprising step which has recently been taken by the American Illuminating Engineering Society is the issue of 'A Primer on Illumination.'

This consists in an illustrated and readable pamphlet, about twenty pages long, containing a summary of some of the most simple and fundamental rules of illumination. This has been reproduced and circulated very widely in the United States, and I have been asked to cooperate by arranging for the issue of a similar publication in this country. We are accordingly arranging to publish in *The Illuminating Engineer* a version of the 'Primer,' slightly modified to suit the conditions of this country, which will subsequently be reprinted. The subject-matter is applicable to all illuminants, and we are hoping that the distribution of this 'Primer' will do much to spread abroad a knowledge of the Illuminating Engineering movement.

Visits to Boston, Philadelphia, and Harrison, N.J.

In Boston I had the opportunity of again meeting Dr. Louis Bell, and in company with him examined the latest developments of street lighting, mainly by means of magnetite arc lamps. I had also a long interview with Mr. Wrightington, Vice-President of The Consolidated Gas Company, and I observe that trials are being made with high-pressure gas.

In some of the cities of the United States (*e.g.*, Newark) what is termed as the "Great White Way" movement has been vigorously pushed. Through the assistance of Mr. P. S. Millar, and through the courtesy of the local supply authorities, I had an opportunity of observing such spectacular street lighting, the brilliancy of which in some cases exceeds anything that I have seen in this country. On the other hand, there seems sometimes a disposition to flood the street with light without paying quite enough attention to the scientific aspects of illumination, so that the effect is glaring. The initial result of this movement has been to attract attention to certain streets and to increase their commercial value. However, in some instances the merchants have found that the lighting of their shops appeared relatively dim in comparison, and it soon became necessary to increase their window lighting so as to be on the same scale as that in the public streets.

In Philadelphia I had an opportunity of seeing Mr. Gartley, and of visiting in the company of Dr. Ives, the works and laboratory of the United Gas Improvement Company. I had also a most interesting conversation with Mr. Mason, of the Welsbach Gas Company. The United Gas Improvement Company has taken the enterprising step of establishing an illuminating engineering research laboratory, and has placed Dr. H. E. Ives in charge. There are now quite a number of gas and electric companies in the United States that have established illuminating engineering departments. The same spirit of enterprise was to be seen in the General Electric Company's works at Harrison, N.J. Prof. S. W. Ashe gave me particulars of the elaborate courses of instruction, both in Illuminating Engineering and in Salesmanship, given to the employees of the Company. The equipment of the laboratories and lecture theatres for demonstrating the use of lamps and reflectors was found very complete and ingenious.

At Schenectady I visited the research laboratory of the General Electric Company, where I spent a very pleasant afternoon with Dr. Steinmetz and Dr. Whitney, both of whom consented to become members of our Society. Dr. Whitney, the inventor of the drawn-wire tungsten lamp, kindly showed me round the research laboratory of which he has charge, where some most interesting researches on improving metal filament lamps are now going on. I have no doubt that our practice of securing support in all corners of the world through our Corresponding Members will be very helpful in years to come.

Association Island.

I may, perhaps, conclude this note by reference to the camp life at Association Island, on Lake Ontario, of which I am showing several slides. The island on which the camp is situated occupies sixty-five well-wooded acres. Besides the meeting tents there are tennis courts, baseball grounds, and

other places of amusement. During the last few years the Association has benefited by experience, and the equipment of the camp has been made more complete. During a large portion of the year many of the chief members of the Association assemble at the island to discuss matters of policy under pleasant and hygienic conditions. Many important meetings take place on the island, and problems of vital importance to the lighting industry and lamp manufacture are discussed. I myself spent a few days on the island, and this is one among many pleasurable recollections that I carried away of my visit.

Several events that have occurred since my return to England deserve notice.

It was also my good fortune, as a member of the Textile Institute, to be present at the Congress held at Hawick during September last. I had an opportunity of coming into contact with many members of the Institute, all of whom recognized the great field for Illuminating Engineering in connexion with textile works. The illumination of these intricate cotton-spinning and weaving machines is a most important problem, and there can be no question that the existing methods of lighting in many mills and factories might often be improved. In addition to this, there are special problems, such as the production of "artificial daylight" and the correct revealing of colour values, which are of vital importance to the industry.

There seems to be a great field for the illuminating engineer in textile work, and I hope that at the next Congress Illuminating Engineering will be brought forward more prominently, and due recognition given to the value of good lighting in textile work.

Subsequently I was present at the First Annual Meeting of the British Commercial Gas Association in Manchester, and was much interested in the scheme advanced for promoting co-operation between all sections of the gas industry. The step is a momentous one that cannot be passed by in an account of the important events of the last few months. I trust that the new movement, if wisely guided, will be productive of good, not only to gas, but to the lighting industry as a whole.

Light and Illumination.

Their Use and Misuse.

This series of articles commencing on the opposite page is intended to convey in simple and concise language some of the main points to be observed in good lighting. To-day when so many illuminants are available it is more than ever to be desired that the light should be *wisely and carefully used.*

Naturally it is not possible to cover the whole subject of illumination in a small publication such as this. On this occasion it is only desired to give a few general recommendations. Specific problems such as the lighting of schools, shops, factories, &c., will be treated in detail at a later date, and it will then be seen more clearly how these principles should be carried out in practice.

The information applies equally to all illuminants. By the proper use of the sources of light (whether gas, oil, electricity, or any other illuminant), good illumination can be secured; but their misuse may result in lighting that is inefficient, costly, and prejudicial to eyesight.

Light and Illumination: their Use and Misuse, will be reprinted in pamphlet form for distribution. In this first version illustrations of electric lighting have been used but it is hoped in a subsequent edition to introduce illustrations of gas lighting.

LIGHT AND ILLUMINATION.

Their Use and Misuse.

The Human Eye.

It is through the eye that our impressions of a lighted interior are received. One should therefore know something of the nature of this organ in order to understand why some lighting conditions are pleasant and others are the reverse.

Fig. 1 is a diagram of the human eye. The light first passes through an outer transparent layer, known as the cornea, then through the chamber behind, and the eye-lens, ultimately reaching the very delicate and sensitive layers on the retina, where the impression of light has its origin. This impression is dispatched to the brain by the optic nerve.

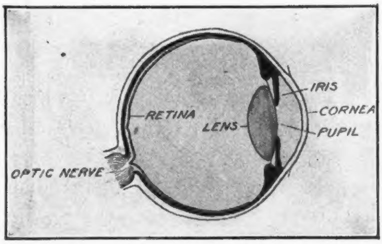


FIG. 1.—Diagrammatic sketch of the eye.

Now the retina itself has the power of adapting itself to light and darkness in a wonderful manner. Besides this, the pupil aperture of the eye acts as a safeguard, opening to its fullest extent in comparative darkness so as to let in as much light as possible, but contracting in proportion to the brilliancy of the illumination so as to shut out excess of light.

FIG. 2 (a).—Pupil aperture of eye, wide open in the darkness so as to let in as much light as possible.

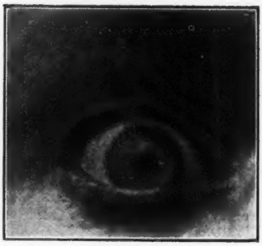


FIG. 2 (b).—Pupil aperture of eye contracted so as to shut out excess of light.

Partly by the alteration of the pupil aperture, and partly also by changes that take place in the retina, the eye can adapt itself to wide changes in the illumination. But the process of adaptation *takes time*, and is only possible within certain limits. If the eye is exposed to *very sudden* contrasts in brightness, or to a brilliancy so great that it cannot protect itself, the eye is bound to suffer.

The fundamental rules of good illumination are all based on the behaviour of the eye. *The eye needs a steady light.* If the illumination is constantly changing and flickering the eyes endeavour to adapt themselves to these changes, and the effect is fatiguing. Every one knows how trying it is to read by an unsteady light, and such conditions should always be avoided.

Avoid :—Flickering Lights,
Glare from Unshaded Lamps,
Glare from Shiny Paper.

Above all, *brilliant unshaded sources of light should not be placed in the direct range of sight.* Whenever the eye is exposed to bright objects of this kind it is dazzled. It makes an effort to adapt itself to the brightness, so that moderately illuminated surfaces (such as the page of a book) appear dark in comparison. In many cases after staring at a bright source for a short time and then transferring the gaze to a relatively dark background, one can see a bright "after-image," showing that the eye has been temporarily fatigued, and it takes some little time to return to its normal condition.

This effect is commonly described as "*glare.*" An extreme instance of glare is afforded by the effect of the brilliant lights of a motor car coming towards one on a dark road. In these circumstances one can see only the lamps. The eye is dazzled and cannot make out the surroundings. But the driver, from whose eyes the direct rays from the lamps are screened, is able to do so.

In the same way a brilliant unshaded light placed at the top of a flight of stairs may actually prove inconvenient to a person about to descend, instead of helping him. A light so placed dazzles the eyes and makes it very difficult to see into the obscurity beyond. But if the lamp is covered by a reflector screening its bright surface from view and throwing the light down on the stairs, it is of real service.

The motto should therefore be kept in mind :—"*Light on the object, not in the eye.*"

Another form of glare to be guarded against is the direct reflected light from polished surfaces. This effect is sometimes met with when very shiny paper is used, and may occur in workshops when polished metal surfaces, &c., have to be examined. It can be guarded against by *care as to the position of lamps* with respect to the work illuminated, and by the use of appropriate methods of light distribution. It is in general preferable to avoid the use of extremely shiny paper, especially in the case of books used continuously in schools, offices, &c. However, cases occur (*e.g.*, in reproducing fine illustrations) in which art paper of this kind is considered necessary.

In general it is also better to avoid using mirrors and highly polished material for decorating the walls of a room, since the reflections of lamps (or even of sunlight), are apt to prove distracting.

Bad Local Lighting. The lamp is incompletely covered by the reflector and shines in the eyes of the workman instead of illuminating the work.

Good Local Lighting. The reflector completely screens the lamp from the eyes and concentrates the light on the work—where it is chiefly needed.

THE best method of lighting a room naturally depends on the purpose to which it is put. A private house is rightly illuminated in a different way from an office, factory, shop, or schoolroom.

Distribution of Illumination.

In some circumstances it is desired to illuminate mainly a desk or table where work is to be carried on, and to provide a somewhat lower general illumination. But in most cases, for example, in schoolrooms and offices, where there are a number of desks in a room, all of which require an equal amount of light, a good general illumination is needed. One should therefore aim at producing *even illumination.* This may be done by means of lamps equipped with suitable reflectors placed at proper intervals. Another method is to use an indirect method of lighting, *i.e.*, to place underneath the source of light an opaque reflector which throws the rays on to a white ceiling or other appropriate light-tinted surface, whence they are diffused all over the room. The fact of the light coming from such a large illuminated surface is particularly beneficial in illuminating complicated machinery: in this case it is often necessary for the light to penetrate into corners and small recesses.

A good example of each of these methods is shown in the illustrations on the opposite page.

In the semi-indirect system of lighting a translucent reflector is used, and some of the light is transmitted directly downwards. This method is considered to combine the advantages of the direct and indirect lighting systems.

Cases also occur when strong light at a particular spot (local illumination), is needed. For example a workman at a lathe, an engraver, a watchmaker, &c., might require a lamp placed close to the work so as to illuminate it strongly. But in these cases the lamp should be *completely screened from the eyes* by a suitable reflector concentrating the light where it is needed.

Care should also be taken that the contrast between the local bright illumination and the surroundings in the room is not excessive; a moderate general illumination should be provided in addition so that the surroundings can be seen with comfort. Severe contrasts in brightness are apt to be extremely fatiguing to the eye. On the other hand, it is not desirable to produce a monotonous degree of brightness. The selection of restful tones for the walls of a room, such as light greens and greys, is often beneficial, but very dark tints should be avoided as they absorb too much light.

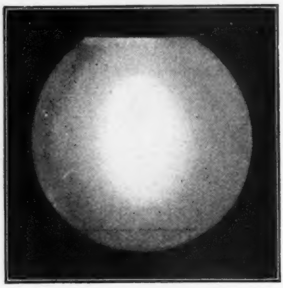
General Illumination of an Office by the Direct Lighting System.

General Illumination of an Office by the Indirect Lighting System.

The Choice of Globes, Shades, and Reflectors.

Globes, shades, and reflectors serve three main purposes:—(1) To soften and diffuse the light and prevent glare; (2) To direct the light where it is chiefly needed; (3) To be ornamental. When arranging the lamps in a room make sure that the shades or reflectors come sufficiently far down over the light source to prevent its being troublesome to the eyes. Many shallow forms of reflectors are unsatisfactory in this respect.

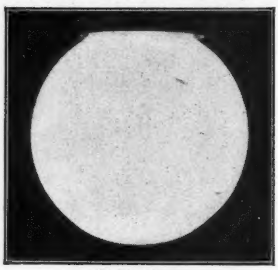
It is also desirable that the shade or globe should soften and diffuse the light; it should appear evenly illuminated all over. The adjacent illustration shows how many lightly ground glass globes do not diffuse the light sufficiently; prismatic and opal glass is usually preferable in this respect.



Lightlv ground glass.
(Unsatisfactory Diffusion.)

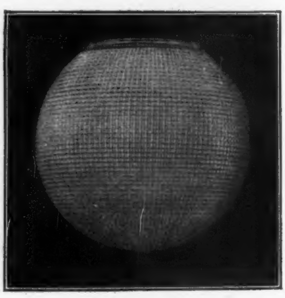
Many forms of shades are merely made of clear glass and serve no useful purpose. Others are so dense or so highly coloured that a great deal of light is absorbed.

In private house lighting, where ornamental effect is considered and the question of economy is often not very vital, silk shades are often used. In this case the danger of getting too little light must be guarded against. It is a good plan to line coloured silk shades with white material which reflects the light downwards, and sometimes a prismatic glass reflector is used under the silk with the same intention.



Opal glass.
(Satisfactory Diffusion.)

Globes and shades are often selected for artistic appearance. But here again it is obvious that an arrangement which is distressing to the eyes will not be decorative in the true sense. When brilliant sources of light are allowed to project from the shade used with them, in such a way as to dazzle the eyes, attention is distracted from the shade itself and the artistic effect may be destroyed.



Prismatic glass.
(Satisfactory Diffusion.)

A BAD EXAMPLE OF TABLE-LIGHTING.

Faulty arrangement of lighting a dining-room table. The lamps are incompletely covered by the shade and shine into the eyes. The effect of glare is accentuated by the dark surroundings.

Direction of Light.

The direction of light is also important. Do not read facing a bright light. This is trying to the eyes. It is also apt to give rise to "glare" in the form of reflected light from shiny paper. When using a table lamp always try to place it so that this inconvenient effect is avoided.

A good arrangement, when one is reading, is for the light to come over the left shoulder. In general, the light should not come from the right since (in the case of a right-handed person) this may lead to an inconvenient shadow being cast by the hand in writing. Lamps should also be so placed that no troublesome shadows are cast by the body. To a person who is bending over work, lights placed immediately overhead are apt to be inconvenient in this respect.

A bare lamp rarely gives the distribution of light that is needed. It is almost always necessary to use an appropriate globe or reflector. For example it will often happen that an oil-flame, electric filament, or gas mantle sends out most of its light sideways, but comparatively little *downwards*, where it is usually wanted. By using a reflector one directs downward much of the light that would otherwise shine into the eyes and cause glare.

Concentrating and Diffusing Reflectors.

Some people are apt to judge the effectiveness of an installation by the apparent brightness of the lamps themselves, but it is much better to consider how far the light is effectively utilised, *e.g.*, whether the actual illumination on the benches, desks, and tables in a room, where the work is actually carried on is sufficient.

Do not think because a lamp looks glaring and brilliant that it is giving you good light, it may be merely giving you too much light in the wrong place. On the other hand a well-shaded table lamp may look dim and yet be giving a first-class light for working.

Various types of reflectors are available. Some are intended to act mainly as *diffusers* of light. They are so constructed that sufficient light is allowed to fall on the walls and ceiling to give a cheerful effect, but the greater part is thrown down over the lower part of the room.

There are also *concentrating* reflectors which are designed to focus the light mainly on a certain restricted area. They are very useful when it is desired to illuminate very strongly a particular spot.

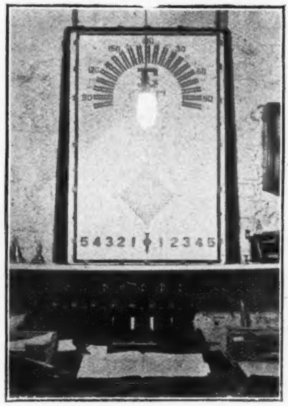
Reflectors may be made either of cardboard, metal, or suitable diffusing and prismatic glass. Concentration of light can be secured by either means; but it must be remembered in using cardboard or metal reflectors, that no light is allowed to pass upwards so that the upper portion of the room will be comparatively dark. On the other hand opaque reflectors of this kind are specially suited for near work, when the lamp is placed close to the observer's eyes.

Concentrating reflectors are very frequently used to focus the light over a bench or table where fine work, requiring a high illumination, is carried on. It may also be necessary to direct the light over an extensive vertical surface, such as a picture, bookshelf, or blackboard. Again in show-window illumination special forms of reflectors are useful according to the dimensions of the window and the area occupied by the goods it is intended to illuminate.

But when it is desired to illuminate a room fairly evenly all over, the use of reflectors which have a very concentrating effect might tend to produce a "patchy illumination," some parts of the room being too strongly lighted and others not receiving enough light. Care should be taken to arrange the lamps at the correct distance apart, corresponding with the type of reflector used.

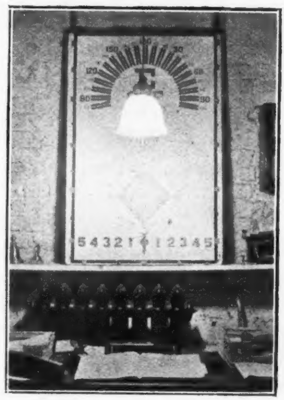
Bare Lamp.

Excess of light on the walls. Insufficient light on the table. Glare from the unscreened source of light.



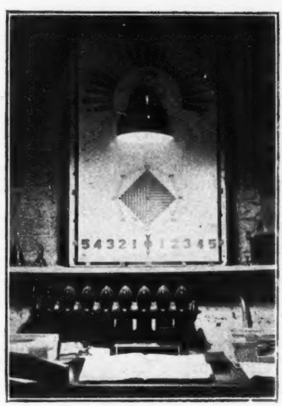
Diffusing Reflector.

Sufficient light shed on the surroundings, but strongest illumination underneath lamp. Source of light now screened from the eyes by translucent reflector.



Concentrating Reflector.

Nearly all the light thrown downwards, and upper part of room in comparative darkness. Source of light completely screened from the eyes by opaque reflector.



Amount of Illumination Necessary.

Besides providing enough light for the surroundings in a room to be seen with comfort, it is most important that *the illumination on the spot where the work is actually carried out should be sufficient.* Experience shows that in order to read ordinary print an illumination of 2-3 foot-candles* is desirable. But for reading very fine print and examining diagrams 5 foot-candles may be needed, while for special work, such as lace-making, engraving, watchmaking, and when working with dark materials which absorb a great deal of light, 7-10 foot-candles or even more may be required. For one must get light to see by, and as one sees chiefly by the aid of light reflected from objects, it is evident that dark coloured things (which reflect light badly) require more illumination than light coloured objects would.

For general illumination, *e.g.*, in parts of the room where reading, writing, &c., does not take place and one only requires enough light to see the surroundings comfortably), ½-1 foot-candle is usually considered ample. An extra strong illumination is often used for advertising purposes and for spectacular effect. For example, in a shop window 20 or even 50 foot-candles may be used.

Effect of Reflection from Walls and Ceiling

In general it is better for the walls and ceiling in a room to be light in tint, since the rays of light reflected from them materially assist the illumination. The substitution of light papers for a very dark and sombre scheme of decoration has been known to *double* the available illumination. Moreover, dark objects, which absorb a great deal of light, themselves require a strong illumination in order to be clearly seen. Consequently a room with dark hangings is apt to seem gloomy unless very strongly lighted.

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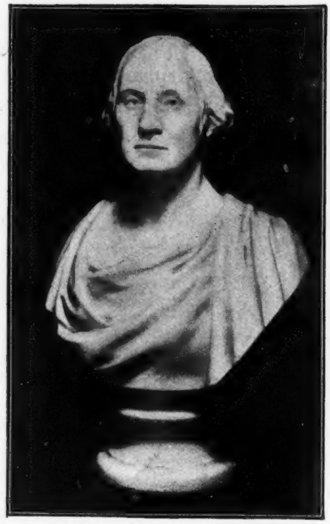
* A foot-candle is the illumination produced by a source of 1 candle-power at a distance of 1 foot. If I represent the intensity of a source at a distance d, and E the resultant illumination $E=\frac{I}{d^2}$. This assumes that the rays of light strike the surface vertically; if they strike it at an oblique angle allowance must, of course, be made for this fact (by multiplying the calculated illumination by the cosine of the angle of incidence).

Thus a 16 candle-power lamp at a distance of 5 feet should give an illumination $=\frac{16}{(5)^2}=0{\cdot}64$ foot-candle.

It is possible to specify and measure the illumination at any spot quite irrespective of the number and arrangement of the lights producing this illumination. In a recent investigation into the lighting of factories conducted by the Home Office over 2,500 measurements of illumination in 125 factories were made.



Bust lighted from above and in front.

The same bust lighted from directly overhead.

THE above illustration shows how entirely the appearance of a bust may be altered according to the position of the lights. The method of shading is also of importance. Bare unscreened lamps tend to give harsh and abrupt shadows. Well-shaded, distributed lights give softer effects, while indirect and semi-indirect methods of lighting give shadows which are softer still.

Effects of Shadow.

Each of these little rooms receives the same light. Dark walls absorb most of the light in the left-hand room.

REMEMBER that good illumination pays. A man cannot do good work if the illumination is insufficient and the lamps are misplaced.

In the Factory.

The cost involved in good lighting is often quite insignificant compared with the wages bill. *Bad illumination means spoiled work, reduction of output, poor health of workers, and frequent accidents.*

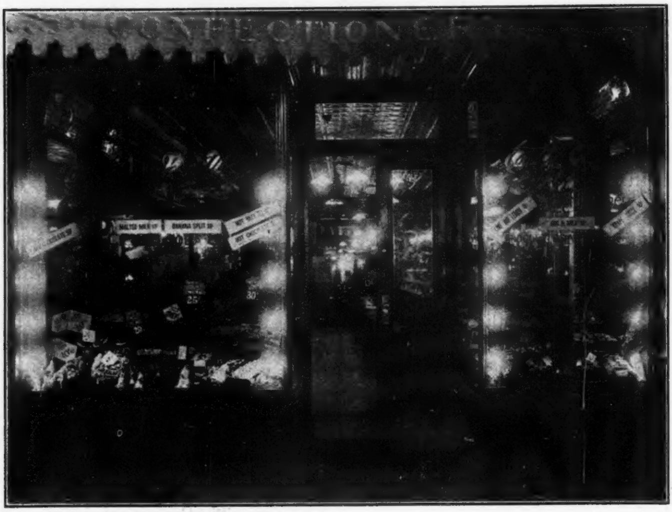
Make sure that the lighting is well arranged to suit the workers, and *keep the lamps and reflectors clean.* A great deal of light is lost when dust and dirt are allowed to accumulate.

General illumination of a printing works by lamps in opaque reflectors. Note the good distribution of illumination secured by the light walls, floor and ceiling.

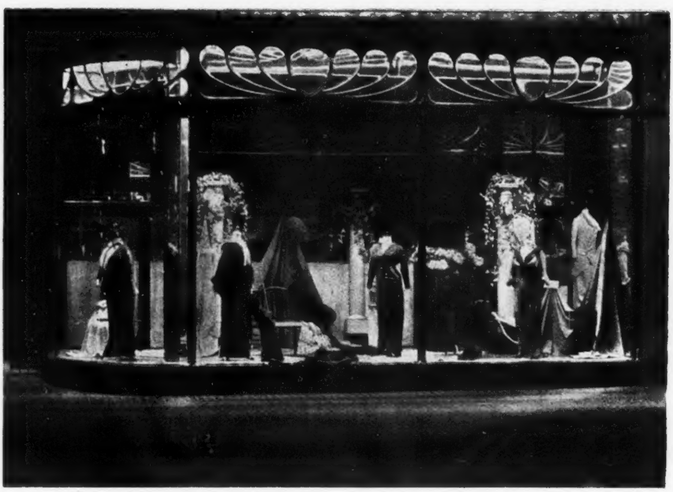
Shop-Window Lighting.

IN illuminating a window try to secure that the light falls upon the goods rather than into customer's eyes. In general, it is preferable to conceal the lamps themselves from view, and under no circumstances should bare lights be placed amongst the contents of the window. Lamps so placed merely dazzle the eyes and defeat their own object.

It is usually preferable to display a few choice goods in the window rather than to crowd into it a miscellaneous collection of objects which it is difficult to illuminate successfully. Remember that the amount of light necessary will depend on the nature of the goods displayed. Very dark materials, which absorb a great deal of light, require a specially strong illumination to be shown properly.



A poor arrangement. The bright lamps dazzle the eyes of people looking in at the window, and relatively little light is shed on the goods.



Window lighted by concealed lamps—a much better method. The sources of light are screened from view and a strong illumination concentrated on the goods in the window.

SOME SIMPLE RULES OF GOOD LIGHTING.

Don't work in a flickering light.

An unsteady, flickering illumination is extremely trying to the eyes.

Don't expose the eyes to unshaded lights in the direct range of vision.

Glare from brilliant unscreened sources of light is prejudicial to eyesight and prevents you from getting the best results from the illumination provided. Lamps should preferably be placed fairly high up in a room out of the direct range of light. If local lights, low down and near to the eyes of the worker, are used, they should be covered by a suitable opaque shade. Do not read facing the light.

Don't judge illumination by the brightness of the lamps.

Do not think because a lamp looks glaring and brilliant that it is giving you a good light. It may be merely giving too much light in the wrong place. On the other hand a well-shaded lamp may look dim *because* it is well-shaded, and may still be giving a first-class light to work by.

Avoid excessive contrast.

If you use a table lamp to provide a strong local illumination, do not leave the rest of the room in complete darkness. Provide a moderate general illumination.

Use the right type of globe, shade, or reflector.

Some forms of globes and reflectors are intended to diffuse the light evenly in all directions, others concentrate the light mainly in one particular direction. See that you get the kind of shade which the local conditions demand. Avoid very shallow reflectors, such as only cover part of the lamp.

Make sure that the illumination is sufficient.

Proper illumination should be provided on the spot where work is actually carried on. 2-3 foot-candles is usually enough to read by. More is needed for special fine work, and when the materials to be illuminated are dark in colour and reflect little light. Rooms with dark walls and ceiling require a greater illumination than those in which the surroundings are light in tint.

Keep lamps, globes, and reflectors clean.

Accumulations of dirt on lamps, chimneys, globes, &c., absorbs and wastes a great deal of light.

Make sure that lamps are in the right position.

When selecting the positions for sources of light consider carefully what purpose they are to serve, and remember the motto, "Light on the object, not in the eye." See that the light comes from the best direction, and that it does not give rise to inconvenient shadows.

Notes on Industrial Illumination.

A RECENT paper by Mr. C. E. Clewell* points out some noteworthy factors in industrial uses of illumination.

We have now an immense variety of electrical illuminants available. But luminous efficiency is not by any means the only factor to be considered. One point which often comes up in connexion with such schemes is the arrangement of the ceiling. Fig. 1 shows the comparative overall lengths of various modern electric lamps, which differ remarkably in this respect. With a low ceiling some of these lamps might be inadmissible. Figs. 2–4 illustrate some typical forms of ceiling construction on which the choice of an illuminant naturally depends.

Mr. Clewell applies the term "engineering efficiency" to various factory installations, by which he means the percentage of the total light produced reaching the actual working plane. This figure was found to vary from 27 to 30 per cent. The effect of accumulations of dirt and dust in reducing this efficiency is very striking; for example, at the end of sixteen days there may be a loss of light of as much as 25 per cent if the lamps and reflectors are not cleaned. It is therefore well worth while to provide a regular cleaning staff in a large factory.

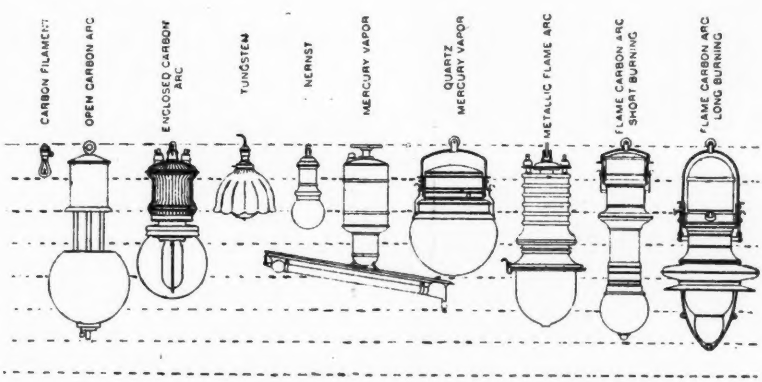
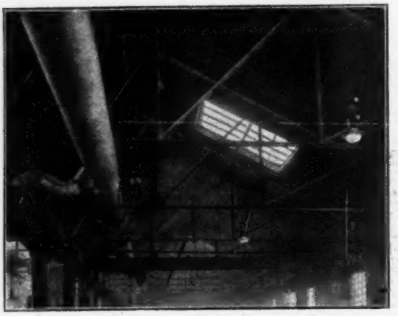


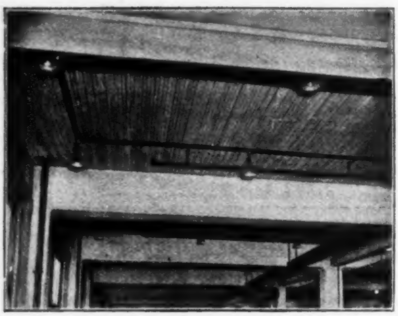
FIG. 1.—Comparative dimensions of various modern electrical illuminants. (*Approximate scale 1 in. = 2 ft.*)

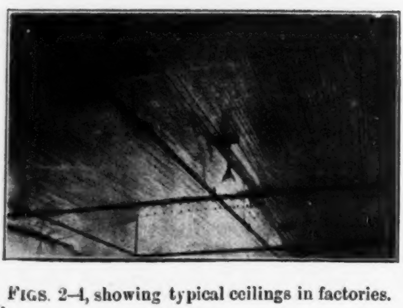
The necessity for proper maintenance is shown by the following example. In one large system of 10,000 tungsten lamps the losses of light per day due to dust and dirt interpreted into money values might amount to twenty dollars a day—or $7,500 per annum.

The author also refers to the question of wages. In the case of almost all skilled labour the gain in improved output and quality of work is out of all proportion to the expense of good

* Proceedings of the American Institution of the Electrical Engineers, July, 1912.







FIGS. 2–4, showing typical ceilings in factories.

lighting. For example, the wages *for six minutes per day* in average shops would pay, not only for meagre, but for entirely adequate illumination. Now the improved efficiency due to the substitution of good lighting conditions for bad ones should surely be at least equivalent to the value of this extra six minutes' work!

But there are many installations in which the introduction of the more efficient illuminants has enabled a large increase in the light to be made with a comparatively small increase in operating costs, or even a saving. For example, in one large shop where extensive installations of high efficiency lamps have been under way nearly three years, a summary shows that an increase of nearly 30 per cent in actual candle-power has been secured for a 5 per cent increase in total operating and maintenance costs.

A German Safety Lamp Competition.

IT will be recalled that the Home Office in Great Britain recently offered a prize for the best miner's lamp.

We see that a similar competition is being organized by the Verein für die Bergbaulichen Interessen, of Dortmund, who offer a prize of £1,250 for the best miner's lamp provided with a trustworthy fire-damp detector.

The lamp and detector must be safe against fire-damp even after damage, and the lamp must give 1 candle-power after running for twelve hours. Lamps and drawings are to be sent to the Verein at Dortmund, from whom further particulars can be obtained, by October, 1913.

Clean Windows in Schoolrooms.

"MORE attention should be given to the cleaning of the windows. In the majority of the schools the windows are only cleaned once a year. A great deal of light is excluded from many of the schoolrooms, through the dirty condition of the windows. The daily sweeping and dusting require to be done much more thoroughly at several of the schools."—Dr. H. H. I. Hitchon, of Heywood: *National Health.*

Lectures on Illuminating Engineering at Regent Street Polytechnic.

On Friday, November 1st, Mr. W. C. Clinton delivered the second lecture of the course of twelve now taking place at the Regent Street Polytechnic.

The lecture was devoted to incandescent electric lighting. An instructive description was given of the work of an electric lighting station, the conditions that affect the price of electricity and the way in which the load varies during the 24 hours. The lecturer then entered upon the history and construction of the incandescent lamp from the early Edison bamboo filament up to the one thousand candle-power metal filament lamps of to-day. The lecturer showed a number of slides illustrating the difference in thickness of carbon filaments and the high voltage low candle-power metal filaments now in use. There were also several ingenious experiments devised to show that the resistance of the carbon filament lamp becomes less when it is heated, while the exact reverse is true of a metal filament. Reference was also made to the recent improvement in the form of drawn-wire filaments.

The next lecture, on November 8th, dealt with electric arc and vapour lamps. The lecturer approached this subject in rather a new way by demonstrating the effect of pressure on the dialectric strength of air. For example, the terminals of an induction coil were led into a closed chamber, and it was shown that the spark could jump across when the chamber was partially exhausted, but could not readily do so at normal atmospheric pressure. Subsequently it was shown how an arc could be started between two electrodes, by discharging a Leyden jar across the gap.

This naturally led to some particulars being given of the Moore tube system, in which a high-tension discharge through rarified gases is used. Subsequently various forms of mercury vapour lamps were shown including the British Westinghouse Silica lamp using a tube of quartz. The use of a new Cooper-Hewitt fluourescent reflector in order to improve the quality of the light was also demonstrated.

Passing on to flame arcs the lecturer described how the early difficulties arising through the deposit of slag on the electrodes was overcome, and gave some important data on the efficiency of modern lamps of this kind. A feature of the display was the series of Excello lamps fitted with carbons giving white, yellow, and pink light, exhibited by the Union Electric Company. A variety of slides showing methods of indirect arc lighting were also shown. At the conclusion of the lecture Mr. Leon Gaster made a few remarks congratulating Mr. Clinton on having so ably reviewed this extensive subject in so short a space of time.

On November 15th and 22nd Mr. J. G. Clark of the Gas Light and Coke Company gave two lectures on gas lighting. The lectures commenced with an account of the operations in a modern gas works. Mr. Clark then also briefly reviewed the early history of the subject, and showed how, by impinging two long flames on one another a broad flame was formed; this was the principle of the "union-jet" burner. Mr. Clark then passed on to describe the regenerative system of preheating the gas supplied to the burner, as exemplified in the Wenham and other early lamps.

The nature of the Bunsen burner was next described, and it was shown how by turning this upside down the inverted burner and mantle were gradually developed; inverted mantles, the lecturer added, were considered to be quite 30 per cent more efficient than the

vertical type. A number of slides were then shown illustrating the manufacture of the artificial silk mantle, the "Robinlyte," and other varieties. Reference was next made to the development of low-pressure high candle-power incandescent lamps and the high-pressure lamps used for modern street lighting A number of good photographs of schoolrooms illuminated by gas were shown, and there was one illustration showing the bracket method of public lighting, which is suitable for very narrow streets, the gas pipe being carried up the wall and then projected over the centre of the road way. Various systems for the distance control of gas lamps by pneumatic and electrical methods (including the Telephos system), were shown; clocks for automatic lighting and extinguishing, the pressure wave method of controlling street lamps, &c., were described. An interesting novelty took the form of a new high candle-power lamp, in which use is made of the vapourization of mercury to create a forced draft, and thus promote an intimate mixture of gas and air and high efficiency.

Mr. Clark next passed on to gas fittings, and remarked on the cheap and inefficient types on the market still to be met; he hoped that the formation of the British Commercial Gas Association would help to improve this state of affairs. Among novel and interesting fixtures shown we may note the special Sug shop-lighting and semi-indirect units to which reference is also made in the 'Trade Notes' in this number.

At the conclusion of the lecture on November 22nd, Mr. Leon Gaster briefly thanked Mr. Clark and the Gas Light and Coke Company for the excellent display of lamps that had been prepared.

The last of the lectures to take place before Christmas, that by Mr. E. Scott Snell on Oil and Petrol-Air Gas Lighting, was delivered on Friday, Nov. 29th.

A Discussion on Direct, Semi-Indirect, and Indirect Lighting.

As indirect lighting is to be the subject of a paper by Mr. W. H. Willcox and Mr. H. C. Wheat at the meeting of the Illuminating Engineering Society in London on December 3rd, it is of interest to notice that a discussion on this subject was arranged by the American Illuminating Engineering Society, and appeared in the June number of the *Transactions*.

The method was adopted of inviting three separate papers by Messrs. T. W. Rolph, J. G. Henninger, and J. G. Hibben respectively on these systems. The three papers together represent a useful and complete analysis of the subject, to which we shall have occasion to refer again shortly. A good feature is the presentation of polar curves of light distribution of the various units —a piece of information which has not been often presented.

The semi-indirect lighting seems to be now coming into fashion, and much discussion took place round the relative proportions in which the direct and indirect illumination components should be combined together; the suggestion was made that the direct illumination should not exceed 15 per cent of the whole. It is evident that some difference of opinion still exists as to the degree of shadow that is desirable. Indirect lighting has often been recommended for drawing offices. Dr. Bell, however, states that draughtsmen complain of the comparative lack of shadow from total indirect lighting.

The Effects of Deficiency of Oxygen on the Light of a Safety Lamp.

An abstract from the paper read by Dr. J. S. Haldane and Dr. T. Lister Llewellyn before the Institute of Mining Engineers, on October 21, 1912.

The effect of moisture on the light given by a safety lamp has not yet been experimentally determined; but recent very careful determinations have shown that the light given by the Standard Harcourt pentane lamp, and the Standard Hefner amylacetate lamp is diminished by 6·25 per cent, and that given by a spermaceti candle by 5·0 per cent for every increase of 1 per cent in the moisture percentage of the air. An addition of 1 per cent of moisture diminishes the true oxygen percentage in pure air by 0·21, and from a set of observations Dr. Haldane found that a diminution of the dry oxygen percentage by 0·21 per cent produces an almost corresponding effect on the light.

It may provisionally be assumed, therefore, that moisture acts on the safety lamp to an extent corresponding roughly to the diminution produced in the true oxygen percentage by adding the moisture. In a mine the barometric pressure is usually greater than at sea level. This causes a slight increase in the light given. With a spermaceti candle the light is increased or diminished about 1 per cent by an increase or diminution of 0·8 in. in barometric pressure. For mines near sea level the effects on the light are therefore so small as to be of little importance. In mines of high altitudes, however, the effects would be considerable, and a given *pressure* of aqueous vapour in air would correspond to a higher *percentage* of moisture, and thus affect a flame much more seriously.

Considerable confusion has arisen through attributing the effects of vitiated air on a flame to increase in percentage of carbon dioxide instead of diminution in oxygen percentage. Air in a mine is hardly ever vitiated by simple addition of CO_2, and the ratio between abstraction of oxygen and the addition of CO_2 is variable in accordance with the variable composition of black damp. For all practical purposes it is the variation in the true oxygen percentage which alone matters. There is, however, one very important exception to this rule, as shown in the paper by Dr. Llewellyn. If the oxygen percentage is diminished by simple addition of a combustible gas such as fire damp, the light given is at first *increased*, although of course the flame will be extinguished when the fire-damp percentage rises to about 5·5, corresponding to an oxygen percentage reduced to 19·8.

In a mine, however, the percentage of black damp nearly always rises with the percentage of fire damp, and the actual effect of the mixture on the flame cannot be predicted from the mere percentage of fire damp, although a moderate percentage of fire damp in the air will, other things being equal, always cause the lamp to give a better light than if the fire damp was absent.

The following table shows the observed percentage diminution of light with observed percentage diminution of oxygen :—

Light given	Oxygen percentage	Light percentage diminished	Oxygen percentage diminished.
100	20·93	0	0·00
90	20·66	10	0·27
77	20·34	23	0·59
66	19·88	34	1·05
41	19·34	59	1·89
27	18·92	73	2·01
11	18·28	89	2·65
0	18·01	100	2·92

Prize Miner's Lamps in the Home Office Competition.

THE following is a brief description of several of the miner's lamps awarded prizes in the recent Home Office Competition. These lamps were exhibited at the meeting of the Illuminating Engineering Society at the Royal Society of Arts on November 19th. We give some particulars, based on information supplied by the manufacturers.

The first prize of £600 was awarded to the **C.E.A.G. Lamp,** entered by F. Färber,

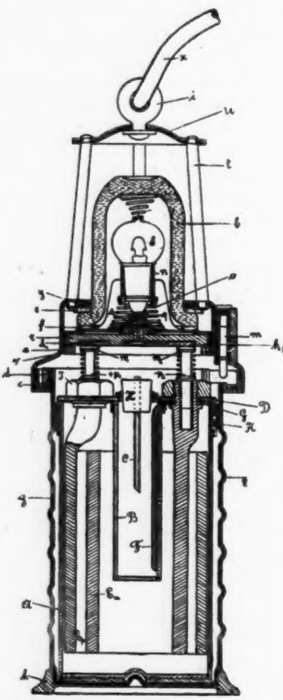


FIG. 1.—Diagramatic view of C.E.A.G. lamp.

a section of which is shown in Fig. 1, while Fig. 2 shows a general view of the lamp.

This lamp consists of three parts, namely, the accumulator and the upper and lower portions.

(1) The accumulator consists of a strong celluloid casing and two circular lead electrodes screwed into the lid of the casing. A novel acid-proof closing arrangement of the battery permits free egress to the gases without allowing the liquid to escape. On both pole ends are two detachable contact-pins on special springs, which form the contact for the current to the glow lamps. This patented arrangement prevents the prejudicial oxidizing of the contacts, as these can be easily cleaned by immersions in warm water. The accumulator is separated by an intermediate space from the steel casing of the lamps, and is thus protected against rough usage.

(2) The bottom of the lamp is a rough, stout casing of heavily turned drawn steel plate, strengthened by steel ribs

FIG. 2.—General view of C.E.A.G. lamp.

pressed into it. The casing is cylindrical in shape, of somewhat conical form.

(3) The top part of the lamp is fastened with a bayonet joint on to the bottom casing, and is therefore easily detachable. The lamp is locked with a magnetic lock, which can only be opened by a strong magnet. The connexion between the loose contact and the glow lamp is effected through a brass segment incased in insulating material, rendering it possible to switch on and off by turning the top part while the lamp is locked.

The glow lamp is a 1·5 candle-power metal filament lamp, burning sixteen hours between intervals of charging the accumulator (which takes from four to five hours). The bulb is protected by a thick glass dome and four iron bars, and placed between spiral springs. By this arrangement a great economy of bulb is realized and immunity from fire-damp, as the circuit is broken automatically when the glass is shattered. The construction is so sound that the lamp can be thrown on to a stone floor with impunity. Its weight dces not greatly exceed 4 lb.

The following lamps also received prizes of £50 each:

The **Stach Lamp**, entered by the Electrical Co., Ltd., is illustrated in Fig. 2. It gives a light of 1·5 candle-power, and one charge lasts for fourteen hours. The

FIG. 3.—General view of Stach lamp.

weight of the lamp is about 5½ lbs. Externally the lower part of the lamp consists of a cylindrical steel welded case, to the top of which is fixed a brass fitting ring. At opposite points on the case are riveted two iron cheeks, to which the carrying hoop is attached. At the top of this hoop is a riveted eye holding a spiked iron hook, by which the lamp may be suspended from a prop whilst in use.

The glass dome is fitted to the upper ring, resting on rubber seating. This upper part also carries the contact-plate, which carries on its upper side the lamp-holder, nickel reflector, and glow lamp, and on its under side the heavily tinned steel springs which make contact with the terminals of the accumulator, and cause the lamp to light up.

The accumulator is contained in a special celluloid case, and is very strongly constructed; its useful life is between 250–300 charges and discharges, and is not damaged by being left months uncharged.

Switching on is performed by turning the lower part of the lamp in a clockwise direction. Even should the glass dome and lamp be broken, there is no danger, and spillage of acid is effectually prevented, largely by glass wool wrapping.

The lamp made by **The Tudor Accumulator Co., Ltd.,** is in general made up of three parts, viz., the lamp case, lamp top (containing the bulb and holder), and the battery.

The lamp case is a seamless cylinder of sheet steel 1 mm. thick and 3⅛ in. in external diameter. The lamp top is fitted on to the case, and secured by means of a "bayonet" fastening. A strong well glass is held firmly in the lamp top, and encloses the bulb. The well glass is protected by a steel disc supported above it by five steel pillars, to which it is riveted. The hook for carrying the lamp is attached by a swivel to this disc.

The lamp is locked by means of a spring catch carried in the lamp top. This catch can only be withdrawn from its notch in the case by means of a magnet, and this prevents the lamp from being tampered with when in use.

The contact pieces are carried on an insulating disc which is secured in the lamp top; this disc also carries the lamp holder, which furthermore serves the purpose of a reflector. The contact pieces bear on the terminals of the battery, and the lamp is switched on or off by slightly turning the top.

The battery is contained in an unspillable celluloid case, and may be inverted and shaken with impunity. The capacity of the battery is sufficient to light a 1·5 candle-power bulb continuously for ten hours. The weight of the complete lamp, including the battery, is 5¼ lbs.

The **Bristol Lamp** is provided with a 4-volt accumulator in a celluloid non-spilling case, and will provide a good light for about ten hours after charge. The case is made of aluminium, and the total weight is only 3 lbs. 6 oz. The lamp is locked by a special key, so that no part of it can be tampered with by unauthorized persons.

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

THE literature of the past month is rather rich in references to illumination. A special issue of *The General Electric Review* (U.S.A.) contains several interesting contributions by C. P. STEINMETZ, ELIHU THOMSON, and L. BELL among others. The last numbers of the *Transactions* of the American Illuminating Engineering Society are occupied with the Convention papers, which were noticed in our last number.

The May number, however, contains several contributions not previously noticed, including a useful analysis of **Show Window Lighting** by J. G. HENNINGER. The author gives a series of diagrams showing the distribution curves of reflectors suitable for narrow and deep windows respectively.

Several photometric articles deserve mention. J. S. DOW (*Elec. World*, Oct. 26) deals with the possibilities of **Physical Photometers,** pointing out that although of possible use for comparative measurements, they are not readily applicable to absolute testing of light. H. KRÜSS describes a somewhat complicated form of mirror arrangement for obtaining the polar curves of very large sources (*J.f.G.*, Nov. 23). Hyde and Cady describe a form of precision bench for photometry (*Elec. Rev.*, N.Y., Nov. 16).

ELECTRIC LIGHTING.

The number of *The General Electric Review* referred to contains articles by HALVORSEN on artistic designs for **Magnetic Arc Lamps,** and A. L. POWELL on the design of **Reflectors for Tungsten Lamps.**

One of the most interesting contributions in this section, however, is that by SCHÄFFER (*E.T.Z.*, Nov. 7), who points out the economy, in lighting very large areas, of sources considerably more powerful than those commonly used at present. He has had favourable experience of the three phase arc giving up to 12,000 H.K., and finds that it lends to a material saving in energy-consumption, carbons, and service. He also gives diagrams of the wave-forms of current taken by lamp. The ideal form would be a flat-topped wave.

GAS, OIL, AND ACETYLENE LIGHTING.

D. J. WINSLOW (*J.G.L.*, Oct. 29) contributes an interesting paper in which several distinct points are dealt with. He describes a method of testing the **reflecting power of papers of various colours** by the light of different illuminants, and makes some general remarks on the effect of light and dark wall-papers in practice. He also discusses the method of "boosting up" to get an increased gas pressure, and finally raises the interesting suggestion that burners should be standardized so that with one and the same type three sizes of mantles can be used. He has had promising experience of an adjustable Grätzin burner of this kind.

E. J. EVANS contributes an able article summarizing recent research on the **Radiation of the Incandescent Mantle,** and LEMPELIUS (*J.f.G.*, Oct. 26) gives a *résumé* of **Novelties in Gas Lighting.** These include the extension of high-pressure and central suspension of street lamps and further progress in the direction of high candle-power low pressure lamps. Maintenance costs are also discussed.

R. F. PIERCE (*Prog. Age*, Nov. 15) gives useful data concerning the distribution of light from various types of lamps, and presents a diagram enabling the spacing rules for even illumination to be obtained for the three characteristic types of Holophane reflectors. The same author, in *The Illuminating Engineer* of New York (October), shows some illustration of semi-indirect gas lighting installations which seem to be now becoming very popular in the States.

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Cheap Grade Mantles (*J.G.L.*, Nov. 12).
Automatic Lighting and Extinguishing of Gas Lamps (*J.G.L.*, Nov. 12).
Lighting of the Leeds Central Markets (*G.W.*, Nov. 2).

CONTRACTIONS USED.

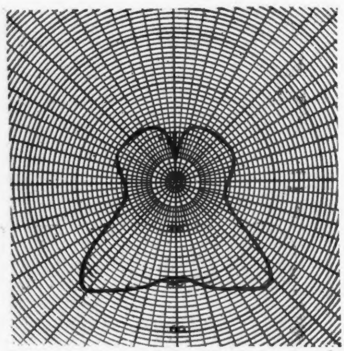
E. T. Z.—*Elektrotechnische Zeitschrift.*
G. W.—*Gas World.*
J. f. G.—*Journal für Gasbeleuchtung swesen.*
J. G. L.—*Journal of Gaslighting.*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

B.T.H. Veluria Reflectors.

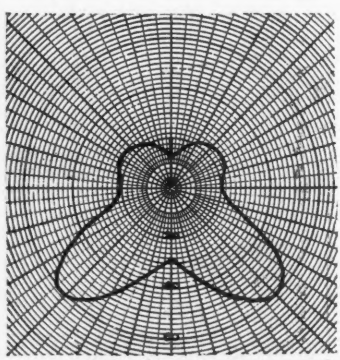
The Veluria glassware introduced by the B.T.H. Co. is an interesting new type of ornamental reflector. Unlighted, the glassware is compared with the shimmering appearance of fine marble; when lighted up it gives a soft mellow illumination, and also acts as an excellent diffuser of light. A characteristic of this type of glassware is the uniformly brilliant surface of the reflector with the lighted lamp inside it. The surface can also be embellished with etched tracery, giving an artistic effect.

Veluria reflector.

Typical curves showing the distribution of light from two such reflectors are shown in the diagrams. Further particulars may be obtained from the British Thomson-Houston Co., at Mazda House, 77, Upper Thames Street, E.C., or the nearest branch office.



Light distributed from Mazda lamp and intensive Veluria reflector.



Light distributed from Mazda lamp and extensive Veluria reflector.

TRADE NOTES.

[At the request of many of our readers we are extending the space devoted to Trade Notes, and are open to receive for publication particulars of new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona fide* information relating thereto.]

Some Novelties in Gas Lighting Fittings.

Some distinctly striking novelties in gas fittings introduced by **Messrs. W. Sugg & Co., Ltd.** (Vincent Works, Regency Street, S.W.), are shown in the adjacent illustrations.

A new semi-indirect lighting unit is shown in Fig. 1. This form of illumination has been taken up very keenly in connexion with electric lighting, and has several distinct advantages, *e.g.*, the fact of the bright source being concealed from the eye and the good diffusion of light into all the corners of the room to be obtained from the illuminated white ceiling; yet since a certain amount of light is transmitted directly downwards the impression of "flatness" which some people

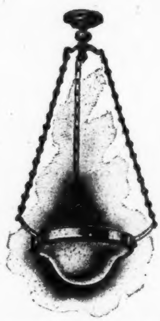


FIG. 1.—Semi-indirect lighting unit.

complain of in the case of totally indirect lighting is not produced.

There is obviously no reason why semi-indirect illumination should not be applied to gas lighting as well as electric, especially as such compact inverted mantles are now available. In the Sugg fitting a bowl of obscured or opal glass is used beneath the mantle, and this gives a very soft and pleasing light. The method of conveying the gas to the burner is also distinctly unique. A flexible tube, unobtrusively passed through one of the three suspending chains, carries the main supply of gas. A second tube for the by-pass supply may be introduced into another of the chains, while the third chain may, if desirable, be utilized to carry a pneumatic tube or the "Telephos" wire, providing for automatic ignition. This method of leading in the gas emphasizes the resemblance to electric lighting, the gas pipe being carried down the chain exactly as the flexible wire used with an electrical lighting fitting of this nature would be.

The next illustration shows a new form of reflecting shop window light. A row

FIG. 2.—Window reflecting light.

of four or more No. 2 inverted burners is placed within a copper casing, enamelled black on the outside and lined with fluted mirrors internally. The mantles are thus completely screened from the eyes of any one at a little distance, and the reflector concentrates the light powerfully downwards. Such a fitting should be of exceptional value for show window

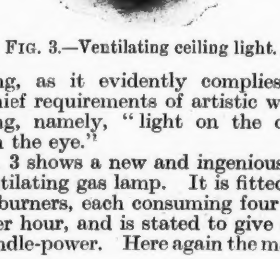


FIG. 3.—Ventilating ceiling light.

lighting, as it evidently complies with the chief requirements of artistic window lighting, namely, "light on the object, not on the eye."

Fig. 3 shows a new and ingenious form of ventilating gas lamp. It is fitted with three burners, each consuming four cubic feet per hour, and is stated to give about 400 candle-power. Here again the mantles

are screened with an obscured glass bowl, which serves to soften the light. The essential novelty in the lamp is the ventilating device. This consists in an inner flue to carry away the products of combustion of the lamp, surrounded by an outer flue. This protects the hot surfaces of the inner tube from contact with surrounding objects, at the same time it sets up a draught and carries away the vitiated air which tends to accumulate near the ceiling.

The remaining illustration shows a bulkhead light, considered specially suitable for the lighting of corridors, passages,

FIG. 4.—Bulkhead for corridor and staircase lighting.

staircases, &c. Here again the resemblance to the corresponding form of unit employed in electric lighting is very close. This fitting utilizes only a single bijou burner, consuming about 1¼ cu. ft. per hour.

Considerable ingenuity is now being brought to bear on gas lighting fittings. At the recent meeting of the British Commercial Gas Association special reference was made to the need for improvement in this respect, and the devices described above suggest that the latent possibilities in gas fittings are coming to be appreciated by up-to-date firms.

Messrs. Falk, Stadelman & Co.'s New Showrooms.

By the courtesy of **Messrs. Falk, Stadelman & Co.** (83, Farringdon Road, E.C.) a visit was recently paid to the new showrooms of this firm, the design of which has been substantially modified during the last three years. From an illuminating engineering standpoint it is interesting to note that this firm deals with gas, electric, and oil fittings, and there are separate showrooms allotted to each section. Two views of these are shown in Figs. 1 and 2.

A notable feature is the way in which all the chief varieties of fittings are subdivided by class, one room being given up mainly to glass shades, another to silk, &c. In the electric division the latest forms of indirect, semi-indirect, and Holophane fixtures are to be seen.

Several very practical methods of displaying the various shades were employed. For example, glass shades are arranged on shelves near the windows, so as to be seen by the transmitted daylight, while the silk and paper shades are usually grouped in glass cases and illuminated by the electric lamps which they cover. This naturally gives a better idea of the effect of a shade by night than when it is merely shown unilluminated.

Another instance of the special diffusion of styles is exemplified in the Dutch room and the French room respectively, where the surroundings and scheme of decoration are made to harmonize with the fittings. The Dutch room, with its handsome panels, tiled fireplace, and antique candelabra, is particularly effective.

Mention may be made of a method of dealing with the back of the showroom which we do not recall seeing elsewhere. The back of the premises, which abut on adjacent buildings and do not receive much daylight, requires special treatment. Some device is needed to remove the impression that the rocm comes to an abrupt termination. Here casement windows have been fitted up and in some instances are illuminated by concealed artificial lights, giving the impression that there is another room behind, in others opening out on painted scenery representing a garden seen through the window; this is illuminated by concealed lamps of appropriate colour, and at a little distance the impression that the rooms open out on a lawn is quite vivid enough to arouse attention and attract the curiosity of the visitor. Lamps of different colours have been installed so that either a morning or an evening effect can be produced.

A word or two may be said about the oil section. These are now in great demand for India, South America, and the Colonies, and lamps giving up to 100 candle-power are supplied. In some instances a combination of black and copper finish gave the lamps a distinctly decorative appearance. In India and tropical countries special requirements have to be met; for example, lamps must sometimes be equipped with a gauze arrangement above the chimney, so as to protect them against the draught of the swinging punkah.

Two views of Messrs. Falk, Stadelman & Co.'s new showrooms.

The Book of the Excello.

Yet another publication from the **Union Electric Company** (Park Street, Southwark) is a booklet with the above title describing the development of the Excello flame arc lamp. It contains a number of good photographs of street lighting, and quite a variety of readable information on the lamps themselves. Lamps equipped with various forms of reflectors are shown, and special attention is devoted to the well-known dioptric and deposit-free globes.

Another list (No. 7208) deals with the "eye-comfort" system of lighting, and contains a summary and analysis of inverted, indirect, and semi-indirect lighting.

Angold Magazine Flame Arc Lamps.

The **General Electric Company's** *Bulletin*, No. 6, is devoted to a description of the Angold magazine flame arc lamps. With these lamps nine or ten pairs of carbons can be filled in the magazine at one time, and a burning life of 60 to 95 hours obtained as a result. Illustrations of various forms of the lamp and a detailed schedule of spare parts are provided, and the booklet concludes with a series of typical installations.

The Gasaccumulator Company, Stockholm, Sweden, draw our attention to the recent trials of the acetylene flash-light signals on the Swedish railways. These are said to give very favourable results, and the Swedish railway authorities have decided to adopt the flash-light for two new types of signals designed by their engineer, Mr. E. G. Windahl. The whole line between Stockholm central station and Saltskog will be so equipped. The combination of colour and flash-light is claimed to facilitate discrimination between the types of signals—an important point in view of the complexity of the arrangements of many large modern railways.

Gas Fires and the Elimination of Fog.

Amongst the undesirable legacies which an excessively wet summer threatens to leave us, *The Lancet* points out in an interesting article, is fog.

Excellent progress has been made in gas-heating. Stove makers have found out that the defective article does not make for the success of their business, and the great gas companies have realized the necessity for a thoroughly scientific appreciation of the problems involved.

The result is, *The Lancet* adds, that domestic heating by means of gas appliances is being approached on right lines and with a success, from a hygienic and economic standpoint, which is rapidly removing the reproach that existed against such a system in former times. As this progress continues we may hope that the movement in favour of smoke abatement will realize its aims.

Beacon Flame Arcs at the Machinery Exhibition, Olympia.

In our last number reference was made to the illumination of the Citreon gear displayed at the Machinery Exhibition, Olympia, by flame arc lamps with parabolic reflectors. We are now informed that these lamps were supplied by **Engineering and Arc Lamps, Ltd.** (St. Albans, Herts).

We are informed that the business of **Messrs. Moffat, Ross & Co., Ltd.,** of 13, Farringdon Road, and the British Ross mantle concern have been amalgamated under the name of Messrs. Ross & Co., Ltd. The new firm has been transferred to larger and more commodious premises at 209, Upper Thames Street, E.C.

Catalogues Received.

Allgemeine Elektricitäts Gesellschaft (Berlin). Particulars of toothed gearing (list No. 10). Electrically driven pumps, compressors and ventilators for mines, gas engines and dynamo electric machinery for mining work.

William Geipel & Co. (Vulcan Works, St. Thomas Street, S.E.). Aluminium electrical conductors, and instructions for erecting and jointing of the same.

Joseph Fox & Sons (Balham, London). Brickwork of all descriptions for boilers.

The October number of *The British Westinghouse Gazette* contains the commencement of an article by Mr. J. S. Leese on illumination. The first section deals mainly with the proper screening and direction of light, special reference being made to the use of steel reflectors for factory lighting.

Junior Institution of Engineers.

Reception and Dance.

The reception and dance of the Junior Institution of Engineers is to be held at the Caxton Hall, Westminster, on Saturday evening, December 14th, 1912, when the President and Lady Dawson will receive the guests in the large hall at 7–7.25 P.M. Tickets (including refreshments) are obtainable at 4*s*. each. Applications should be made to the Secretary, Mr. A. Clifford Swales, 39, Victoria Street, S.W., not later than Tuesday, December 10th.

B.T.H. "Eye-Rest" Lighting in Restaurants.

A new and ingenious application of indirect lighting is shown in Fig. 1. Instead of being held from the ceiling the reflectors are mounted on pedestals, which can be made of wood, metal, or composition, and are susceptible of very artistic treatment.

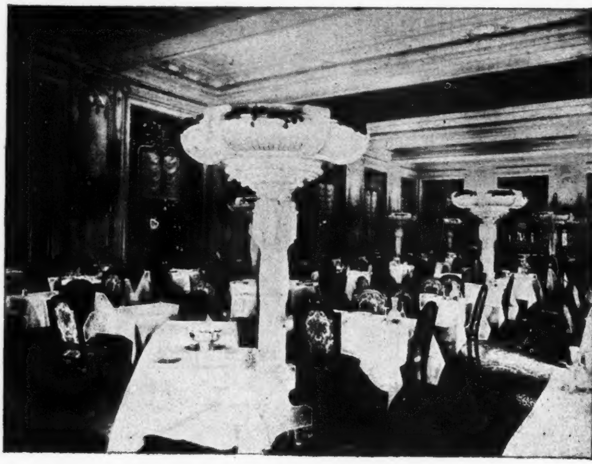


FIG. 1.—Pedestal system of lighting at the Congress Hotel.

This pedestal system, used in conjunction with Mazda lamps and X-ray reflectors, was first installed in a dining-room at the Congress Hotel in Chicago last year, and was described in *The Electrical World* for November, 1911. A similar scheme has been introduced into the new restaurant and hotel at Albany, Denver, Col. This room measures 54 ft. by 40 ft., and is 13 ft. high. It is lighted by four pedestal fittings, each having six 100 watt tungsten lamps in X-ray silvered glass reflectors. The white pedestals are 7 ft. high, thus keeping the lamps well above the eye level, so that the light source is not visible from any part of the room.

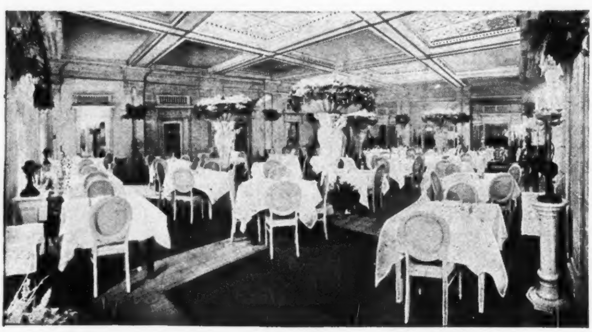


FIG. 2.—Pedestal system of lighting in the Albany Hotel.

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Holophane Lumeter.

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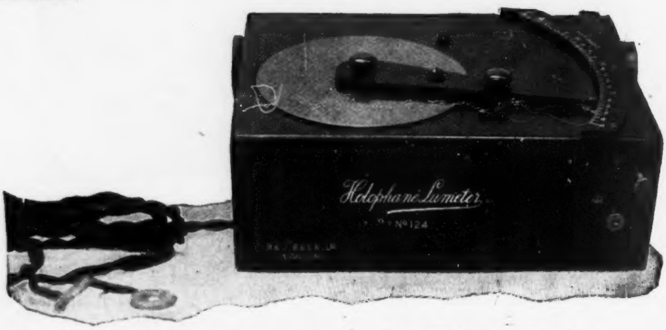

Showing general appearance of new model of Holophane Lumeter.
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